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NOVEMBER 1990

AUTOMOTIVE INDUSTRIES

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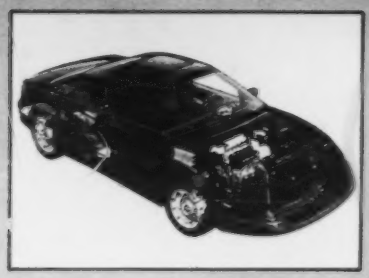

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THE CARS

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The presses were rockin' across America in the 5th annual Die Change Challenge. Page 47.

CHILTON'S
AUTOMOTIVE INDUSTRIES

COVER STORY

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ROBERT G. BURTON
PRESIDENT

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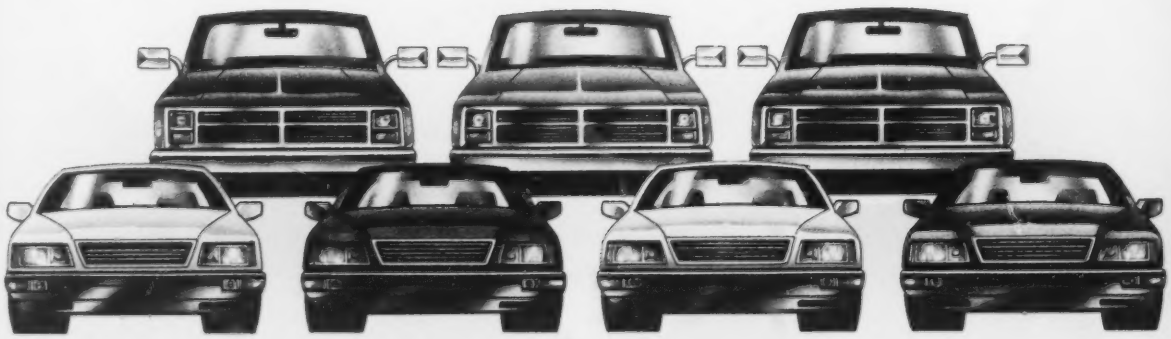

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TWO SEATERS

MODEL	CODE	PLANT LOCATION	PLANT CAPACITY	1989 SALES	EST. 1990 SALES
Acura NS-X	NS-X	Tochigi, Japan	(N/A)	—	3,000
Alfa Romeo Spider	N/A	Turin, Italy	40,000	1,856	1,900
Aston Martin Virage	2034	Newport Pagnell, UK	300	34	50
Buick Reatta	Z	Lansing, MI	24,000	7,905	7,500
Cadillac Allante	V	Turin, Italy/ Hamtramck, MI	10,000	3,276	3,500
Chevrolet Corvette	Y	Bowling Green, KY	57,600	23,928	24,500
Chrysler's TC by Maserati	Q	Lambrate, Italy	40,000	2,924	4,300
Consulier GTP	N/A	Riviera Beach, FL	5,000	N/A	N/A
Ferrari: 348	N/A	Modena & Maranello, Italy	4,000	2,200	N/A
Testarossa	N/A	" "	4,000	1,200	N/A
F40	N/A	" "	4,000	400	N/A
Honda Civic CRX	N/A	Suzuka, Japan	(N/A)	31,011	40,000
Jaguar XJS	XJ27/77	Coventry, UK	80,000	4,458	4,700
Lamborghini Diablo/ Countach	P132	Sant' Agata Bolognese, Italy	2,000	N/A	180
Lotus: Elan	M100	Norwich, UK	5,000	N/A	75
Esprit Turbo	M200	" "	5,000	N/A	270
Maserati Spider	333B28	Modena, Italy	6,000	N/A	N/A
Mazda: Miata	N/A	Hiroshima, Japan	(N/A)	23,007	38,000
RX-7	N/A	" "	(N/A)	16,294	10,700
Mercedes 300/500 SL	R129	Bremen, Ger.	230,000	7,477	7,000
Nissan 300ZX	N/A	Shatai, Japan	(N/A)	20,369	22,000
Toyota MR2	N/A	Kariya, Japan	(N/A)	5,205	15,000

MINICOMPACTS

MODEL	CODE	PLANT LOCATION	PLANT CAPACITY	1989 SALES	EST. 1990 SALES
BMW 850i	E31	Dingolfing, Ger.	264,000	—	50
Ferrari Mondial t	N/A	Modena & Maranello, Italy	4,000	400	N/A
Maserati 228	334B28	Modena, Italy	6,000	2,000	N/A
Nissan 240 SX	N/A	Kyushu, Japan	(N/A)	68,213	53,000
Porsche 911 Carrera	964	Stuttgart, Ger.	30,000	5,714	5,400
928	928	" "	30,000	835	650
944	944	Nekersulm, Ger.	180,000	2,794	3,000
VW Cabriolet	N/A	Osnabruck, Ger.	95,000	9,891	7,700

SUBCOMPACTS

MODEL	CODE	PLANT LOCATION	PLANT CAPACITY	1989 SALES	EST. 1990 SALES
Acura Integra	N/A	Suzuka, Japan	(N/A)	77,433	81,500
Audi Coupe Quattro	N/A	Ingolstadt, Ger.	330,000	342	870
80/90	B3	" "	330,000	9,013	9,300
BMW 3-Series	E30	Regensberg, Ger. Munich, Ger.	135,000 200,000	31,174	30,000
Chevrolet Camaro	F	Van Nuys, CA	199,680	95,469	80,000
Daihatsu: Charade	N/A	Kyoto, Japan	(N/A)	15,118	12,400
Applause	N/A	" "	(N/A)	—	500
Dodge: Daytona	G24	Fenton, MO	210,000	64,097	36,700
Stealth	N/A	Okazaki, Japan	(N/A)	—	500
Dodge/Plymouth Colt	N/A	Kurashiki, Japan	(N/A)	58,299	44,200
Eagle: Talon	H24S	Bloomington-Normal, IL	240,000	7,145	26,000
Summit	N/A	" "	240,000	19,121	14,000
Ford Festiva	BT17	Seoul, South Korea	(N/A)	69,328	57,500
Mustang	FOX	Dearborn, MI	176,640	161,148	121,300
GEO: Metro	M	Kosai, Japan	(N/A)	53,437	72,000
Prizm	S	Fremont, CA	240,000	89,710	122,300
Storm	R	Fujisawa, Japan	(N/A)	62,877	83,400
Honda: Civic	N/A	East Liberty, OH Marysville, OH Alliston, Ontario Suzuka, Japan	150,000 360,000 80,000 657,000	204,441	213,000
Prelude	N/A	Sayami, Japan	533,000	42,882	38,400
Hyundai Excel	X2	Ulsan, S. Korea	(N/A)	142,563	105,000
Infiniti M30	N/A	Oppama, Japan	(N/A)	657	6,200
Isuzu Impulse	N/A	Fujisawa, Japan	(N/A)	3,875	1,800
Maserati 430	332B28	Modena, Italy	6,000	N/A	N/A
Mercedes 190	W201	Sindelfingen, Ger. Bremen, Ger.	405,000 230,000	14,503	12,900
Mercury Capri	SA30	Broadmeadows, Australia	(N/A)	—	8,500
Mitsubishi: Eclipse	H24S	Bloomington-Normal, IL	240,000	32,018	47,500
Mirage	N/A	" " Kurashiki, Japan	240,000 (N/A)	28,796	52,000
3000 GT	N/A	Okazaki, Japan	(N/A)	—	600
Nissan: NX Coupe	N/A	Tochigi, Japan	(N/A)	23,909	7,400
Sentra	N/A	Zama, Japan Smyrna, TN	(N/A) 240,000	221,292	166,700
Plymouth Laser	H24S	Bloomington-Normal, IL	240,000	21,098	39,000
Pontiac Firebird	F	Van Nuys, CA	199,680	55,030	38,500
Rolls Royce Bentley Continental	N/A	Crewe, UK	5,000	N/A	N/A
Cornich III	N/A	" "	5,000	N/A	N/A
Subaru: Justy	N/A	Gunma, Japan Kaoshiung, Taiwan	141,600 42,000	17,792	15,000
XT	N/A	Gunma, Japan	279,600	11,088	2,500
Suzuki Swift	N/A	Ingersoll, Ont. Kosai, Japan	200,000 (N/A)	6,009	7,000

1991 Passenger Cars &

COMPACTS

MODEL	CODE	PLANT LOCATION	PLANT CAPACITY	1989 SALES	EST. 1990 SALES
Acura Legend	HX	Sayama, Japan	533,000	64,638	59,000
BMW 5-Series	E34	Dingolfing, Ger.	264,000	20,492	21,500
Buick Skylark	N	Lansing, MI	230,400	63,725	86,000
Chevrolet:					
Corsica/Beretta	L	Linden, NJ	230,400	326,006	279,000
		Wilmington, DE	230,400		
Cavalier	J	Janesville, WI	230,400	295,715	277,500
		Lordstown, OH	273,600		
Chrysler LeBaron	J	Fenton, MO	210,000	83,965	62,300
Dodge Shadow	P	Sterling Heights, MI	230,400	82,953	70,000
Ford: Escort	CT20	Wayne, MI	264,960	333,535	263,000
		Hermosillo, Mexico	172,800		
Probe	ST16	Flat Rock, MI	260,000	133,650	131,500
Tempo	Topaz	Kansas City, MO	211,200	228,426	225,000
		Oakville, Ont.	230,400		
Honda Accord	N/A	Marysville, OH	360,000	362,707	425,000
		Sayama, Japan	533,000		
Isuzu I-Mark (Stylus)	N/A	Fujisawa, Japan	(N/A)	12,421	2,700
Jaguar XJ-6	XJ40	Coventry, UK	80,000	14,509	13,800
Lexus ES250	N/A	Tsutsumi, Japan	(N/A)	4,728	18,500
Mazda: 323	N/A	Hiroshima, Japan	(N/A)	61,037	24,000
Protege	N/A	" "	(N/A)	9,935	45,500
Mercedes:					
300	W124	Sindelfingen, Ger.	405,000	26,243	30,800
560SEC	W126	" "	405,000	1,702	1,900
Mercury: Topaz	Topaz	Kansas City, MO	211,200	85,732	75,000
		Oakville, Ont.	230,400		
Tracer	CT20	Hermosillo, Mexico	172,800	57,966	29,000
Mitsubishi:					
Galant	N/A	Nagoya, Japan	(N/A)	30,511	41,000
Sigma	N/A	" "	(N/A)	2,100	1,900
Nissan Stanza	N/A	Oppama, Japan	(N/A)	42,736	74,800
Olds Cutlass					
Calais	N	Lansing, MI	230,400	95,254	100,000
Peugeot 405	D60	Ryton, UK	110,000	3,825	3,100
		Sochaux, France	400,000		
Plymouth					
Sundance	P	Sterling Heights, MI	230,400	84,335	61,100
Pontiac:					
Grand Am	N	Lansing, MI	230,400	202,815	209,000
LeMans	T	Inchon, S. Korea	(N/A)	44,641	41,000
Sunbird	J	Lordstown, OH	273,600	101,991	107,500
Saab 900	N/A	Trollhattan, Sweden	120,000	22,471	19,800
		Uusikaupunki, Finland	(N/A)		
Sterling 827	XX	Cowley, UK	110,000	5,907	4,400
Subaru: Legacy	N/A	Gunma, Japan	279,600	33,707	69,000
		Lafayette, IN	60,000		
Loyale	N/A	Gunma, Japan	279,600	12,200	20,500
Toyota: Camry	N/A	Georgetown, KY	240,000	259,176	265,300
		Tsutsumi, Japan	(N/A)		
Cressida	N/A	Motomachi, Japan	(N/A)	23,934	12,500
Volkswagen:					
Golf	A3	Wolfsburg, Ger.	900,000	22,247	18,200
		Forest, Belgium	210,000		
Jetta	N/A	Wolfsburg, Ger.	900,000	55,504	59,000
Volvo: 240	N/A	Goteborg-Torslanda, Sweden	150,000	40,881	33,600
		Ghent, Belgium	95,000		
780	N/A	Turin, Italy	40,000	2,057	1,000

MIDSIZE

MODEL	CODE	PLANT LOCATION	PLANT CAPACITY	1989 SALES	EST. 1990 SALES
Alfa 164	Type 4	Arese, Italy	150,000	—	960
Avanti	N/A	Youngstown, OH	1,500	300	300
Audi: V8	D2	Neckarsulm, Ger.	180,000	918	1,800
100/200	C4	" "	180,000	8,473	10,200
BMW 7-Series	E32	Dingolfing, Ger.	264,000	10,399	8,600
Buick: Century	A	Oklahoma City, OK	288,000	134,682	114,000
Regal	W	Oshawa 2, Ont.	261,120	76,003	78,500
Riviera	E	Hamtramck, MI	240,000	19,208	20,300
Cadillac:					
Eldorado	E	Hamtramck, MI	240,000	30,051	23,000
Seville	K	" "	240,000	23,030	35,500
Chevrolet:					
Lumina	W	Oshawa 1/2, Ont.	460,000	109,705	229,000
Celebrity	A	Ste. Therese, Quebec	160,080	141,796	39,100
Chrysler:					
LeBaron	A	Newark, DE	230,400	—	65,000
New Yorker	C	Belvedere, IL	226,560	70,756	45,800
Dodge: Dynasty	C	" "	226,560	109,250	90,500
Spirit	A	Newark, DE	230,400	76,558	83,000
Ford: Taurus	DN5	Atlanta, GA	249,600	348,061	312,000
		Chicago, IL	249,600		
Thunderbird	MN12	Lorain, OH	299,520	120,645	105,500
Hyundai Sonata	Y2	Bromont, Quebec	100,000	34,698	31,600
		Ulsan, S. Korea	(N/A)		
Infiniti Q45	N/A	Tochigi, Japan	(N/A)	1,072	10,600
Lexus LS400	N/A	Tahara, Japan	(N/A)	11,574	37,400
Lincoln Mark VII	LS	Wixom, MI	184,320	24,620	21,200
Mercury: Cougar	MN12	Lorain, OH	299,520	99,673	78,000
Sable	DN5	Atlanta, GA	249,600	110,962	98,500
		Chicago, IL	249,600		
Maserati 228	334B28	Modena, Italy	6,000	N/A	N/A
Mazda: 626	N/A	Flat Rock, MI	260,000	55,044	63,400
929	N/A	Hiroshima, Japan	(N/A)	19,390	16,500
MX-6	N/A	Hofu, Japan	(N/A)	41,532	29,600
		Flat Rock, MI	260,000		
Mercedes:					
300 SEL	W126	Sindelfingen, Ger.	405,000	3,822	5,900
350 SDL Turbo	W126	" "	405,000	2	830
420 SEL	W126	" "	405,000	7,493	7,000
560 SEL	W126	" "	405,000	5,460	5,000
Nissan Maxima	N/A	Oppama, Japan	(N/A)	109,429	98,500
Olds:					
Cutlass:					
Ciera	A	Oklahoma City, OK	288,000	190,720	128,000
		Ste. Therese, Quebec	160,080		
Supreme	W	Doraville, GA	250,000	99,898	96,000
Cruiser	A	Oklahoma City, OK	(N/A)	N/A	N/A
Toronado	E	Hamtramck, MI	240,000	10,125	15,800

Light Trucks Sold in the U

MODEL	CODE	PLANT LOCATION	PLANT CAPACITY	1989 SALES	EST. 1990 SALES
Plymouth					
Acclaim	A	Newark, DE	230,400	92,017	99,900
Pontiac:					
6000	A	Oklahoma City, OK	288,000	67,681	46,500
Grand Prix	W	Fairfax, KS	250,000	113,216	112,000
Rolls Royce:					
Bentley Eight	N/A	Crewe, UK	5,000		
Bentley Mulsane	N/A	" "	5,000	1,216	1,300
Silver Spirit II	N/A	" "	5,000		
Silver Spur	N/A	" "	5,000		
Volkswagen					
Passat	B3	Emden, Germany	264,000	—	2,000
		Brussels, Belgium	210,000		
Volvo: 740	N/A	Goteborg-Torslanda	150,000		
		Uddevalla, Sweden	40,000	47,098	49,000
		Ghent, Belgium	95,000		
		Halifax, N. Scotia	10,000		
760	N/A	Kalmar, Sweden	35,000	11,811	8,700

LARGE

Buick:					
Electra/ Park Avenue	C	Wentzville, MO	249,600	77,621	55,000
Le Sabre	H	Flint, MI	192,000	147,321	143,000
Estate Wagon	B	Lakewood, GA	(N/A)	N/A	6,800
		Willow Run, MI	240,000		
Cadillac:					
Brougham	D	Arlington, TX	230,400	39,858	32,500
DeVille/ Fleetwood	C	Orion, MI	240,000	170,459	153,000
Chevrolet					
Caprice	B	Arlington, TX	230,400	148,823	160,000
		Willow Run, MI	240,000		
Chrysler:					
New Yorker	C	Belvedere, IL	226,560	47,405	46,300
Fifth Avenue	Y	" "	226,560	12,336	35,000
Imperial	Y	" "	226,560	2,226	10,500
Dodge Monaco	B	Bramalea, Ont.	153,600	—	7,600
Eagle Premier	B	Bramalea, Ont.	153,600	39,546	20,000
Ford LTD					
Crown Victoria	Panther	St. Thomas, Ont.	230,400	108,085	103,000
Lincoln:					
Continential	FN9	Wixom, MI	184,320	56,441	59,000
Town Car	FN36	" "	184,320	119,254	138,500
Mercury Grand					
Marquis	Panther	St. Thomas, Ont.	230,400	111,575	97,000
Olds: 88	H	Flint, MI	192,000	138,357	102,000
		Wentzville, MO	249,600		
98	C	Wentzville, MO	249,600	65,671	54,000
		Orion, MI	230,400		
Custom Cruiser	B	Willow Run, MI	240,000	N/A	3,700
		Arlington, TX	230,400		
Peugeot: 505	E30	Sochaux, France	400,000	2,270	1,400
605	Z6	" "	400,000	—	N/A
Pontiac					
Bonneville	H	Wentzville, MO	249,600	87,642	65,600
Saab 9000	Type 4	Trollhatten, Sweden	120,000	8,835	8,700
		Malmo, Sweden	60,000		

MODEL	CODE	PLANT LOCATION	PLANT CAPACITY	1989 SALES	EST. 1990 SALES

SPORT/UTILITY

Chevrolet:					
Blazer	N/A	Flint, MI	192,000	22,816	19,000
Suburban	N/A	" "	192,000	65,425	59,100
S-10 Blazer	N/A	Pontiac, MI	115,200	177,819	156,000
		Shreveport, LA	190,080		
		Moraine, OH	215,040		
Daihatsu Rocky	N/A	Osaka, Japan	(N/A)	295	4,000
Dodge:					
Raider	N/A	Nagoya, Japan	(N/A)	9,450	3,600
Ramcharger	N/A	Warren, MI	215,040	18,973	12,500
		Lago Alberto, Mexico	(N/A)		
Ford:					
Bronco	N/A	Wayne, MI	142,080	62,563	54,500
Explorer/ Bronco II	N/A	Louisville, KY	307,200	108,990	149,000
GEO Tracker	N/A	Ingersoll, Ont.	200,000	11,461	30,000
		Kosai, Japan	(N/A)		
GMC:					
Suburban	N/A	Flint, MI	192,000	23,651	24,600
Jimmy	N/A	" "	192,000	6,723	5,500
S-15 Jimmy	N/A	Moraine, OH	215,040	44,850	42,000
		Pontiac, MI	115,200		
		Shreveport, LA	190,080		
Isuzu:					
Amigo	N/A	Fujisawa, Japan	(N/A)	6,318	9,800
Trooper	N/A	" "	(N/A)	50,079	47,500
Rodeo	N/A	Lafayette, IN	120,000	—	600
Jeep:					
Cherokee	XJ	Toledo, OH	240,000	156,118	126,000
Wagoneer	XJ	" "	240,000	6,537	4,000
Grand Wagoneer	N/A	" "	240,000	10,715	7,600
Wrangler	YJ	Brampton, Ont.	81,600	50,726	52,300
LaForza	N/A	Turin, Italy	40,000	145	200
Mitsubishi					
Montero	N/A	Nagoya, Japan	(N/A)	14,118	16,000
Nissan					
Pathfinder	N/A	Kyushu, Japan	(N/A)	17,012	26,100
Olds Bravada	N/A	Moraine, OH	215,040	—	400
Range Rover	N/A	Solihull, UK	110,000	4,822	4,600
Suzuki:					
Samurai	N/A	Kosai, Japan	(N/A)	5,038	5,000
Sidekick	N/A	Ingersoll, Ont.	200,000	19,131	10,200
		Kosai, Japan	(N/A)		
Toyota:					
Land Cruiser	N/A	Tahara, Japan	(N/A)	5,091	5,200
4 Runner	N/A	" "	(N/A)	44,644	52,000

MINIVAN

Chevrolet:					
Astro	N/A	Baltimore, MD	199,920	143,941	124,500
Lumina APV	U	Tarrytown, NY	253,440	9,708	61,500

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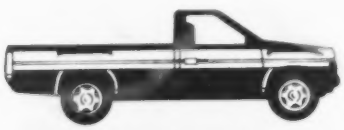
MODEL	CODE	PLANT LOCATION	PLANT CAPACITY	1989 SALES	EST. 1990 SALES
Chrysler Town & Country	T115	Fenton, MO	210,000	1,812	3,000
Dodge Caravan	T115	Windsor, Ontario Fenton, MO	249,600 210,000	219,575	220,000
Ford Aerostar	N/A	St. Louis, MO	199,920	188,130	180,000
GMC Safari	N/A	Baltimore, MD	199,920	31,681	33,200
Mazda MPV	N/A	Hiroshima, Japan	(N/A)	37,211	41,500
Mitsubishi Van	N/A	Nagoya, Japan	(N/A)	910	1,900
Olds Silhouette	U	Tarrytown, NY	253,440	2,122	20,500
Pontiac Trans Sport	U	Tarrytown, NY	253,440	3,266	27,000
Plymouth Voyager	T115	Windsor, Ont. Fenton, MO	249,600 210,000	184,943	180,000
Toyota Previa	N/A	Kariya, Japan	(N/A)	—	15,000
Volkswagen Vanagon	N/A	Hannover, Ger.	(N/A)	5,147	6,700

SMALL PICK UP TRUCKS

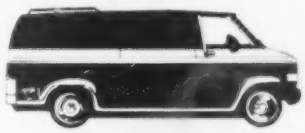
Chevrolet S10	N/A	Moraine, OH Shreveport, LA Pontiac West, MI	215,040 190,080 115,200	228,691	200,000
Dodge Ram 50	N/A	Nagoya, Japan	(N/A)	28,967	14,500
Ford Ranger	N/A	Louisville, KY Twin Cities, MN Edison, NY	307,200 165,120 215,040	284,125	286,000
GMC S15 Sonoma	N/A	Moraine, OH Shreveport, LA Pontiac West, MI	215,040 190,080 115,200	52,601	46,000
Isuzu Pickup	N/A	Lafayette, IN	120,000	46,976	44,300
Mitsubishi Pickup	N/A	Nagoya, Japan	(N/A)	22,135	22,700
Nissan Hardbody	N/A	Smyrna, TN	240,000	132,624	130,000



STANDARD PICKUPS

Chevrolet C/K	GMT400	Fort Wayne, IN Pontiac, MI Oshawa, Ont.	230,400 230,400 230,400	482,922	495,000
Dodge					
Power Ram 50	N/A	Nagoya, Japan	(N/A)	90,302	12,000
Dakota	N/A	Warren, MI	215,040	89,294	78,000
D/W100-250	T300	" "	215,040	24,055	97,500
Ford F Series	N/A	Kansas City, MO Wayne, MI Norfolk, VA Twin Cities, MN Oakville, Ont.	145,920 142,080 157,440 165,120 145,920	366,387	545,000
GMC C/K	GMT400	Fort Wayne, IN Pontiac, MI Oshawa, Ont.	230,400 230,400 230,400	148,715	144,000

MODEL	CODE	PLANT LOCATION	PLANT CAPACITY	1989 SALES	EST. 1990 SALES
Isuzu Pickup	N/A	Lafayette, IN Fujisawa, Japan	120,000 (N/A)	46,975	44,500
Jeep Comanche	N/A	Toledo, OH	240,000	25,074	16,000
Mazda B2200-2600	N/A	Hiroshima, Japan	(N/A)	73,492	76,000
Mitsubishi 4WD	N/A	Nagoya, Japan	(N/A)	1,544	3,000
Toyota Pickup	N/A	Tahara, Japan	(N/A)	222,813	180,500



VANS

Chevrolet	G	Lordstown, OH Scarborough, Ont.	115,200 110,160	114,999	116,000
Dodge Ram	N/A	Pillette Road Windsor, Ont.	115,200 249,600	67,812	82,000
Ford Econoline	N/A	Lorain, OH	218,880	166,233	177,000
GMC	G	Lordstown, OH Scarborough, Ont.	115,200 110,160	40,534	38,000

ARCO Chemical Worldwide Locations

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Newtown Square, PA 19073
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AUTOMAKER QUARTERLY REPORT

by DR. THOMAS O'GRADY

With skyrocketing gasoline prices and renewed fears of a recession, US passenger car sales dropped by 10.3% in the third quarter of 1990 in comparison to the same period last year.

Integrated Automotive Resources' consumer survey, Automotive CPR, was conducted immediately following the August 2nd invasion of Kuwait by Iraq and revealed that a large number of buyers would postpone their purchase decisions for several reasons stemming from uncertainty. Few buyers, however, were willing to sacrifice their present level of engine performance because of gas price increases.

General Motors was the only Big Three automaker to eke out an increase in its passenger car market share. In the third quarter of 1990, GM captured a 35.5% share, up from 35.3% in 1989. Honda was able to surpass Chrysler in passenger car sales by 15,521 units this quarter. In addition, Toyota's car sales – not including minivans and sport utility vehicles – came within 3514 units of Chrysler's car sales for the quarter. But Chrysler still significantly maintains the lead over both in total vehicle sales.

Recession-wary consumers are postponing new car purchases, but those that do buy are not willing to sacrifice engine performance because of gas prices.

After an impressive comeback last year, Nissan's sales this quarter slipped by 10.3%. Mitsubishi dropped out of the top ten manufacturers as it prepares to debut several new products on the US market. Volkswagen/Audi moved ahead of Hyundai and Subaru in car sales this quarter.

When car sales were examined by geographic base, we found that American, Japanese and "other" imports lost share while the transplants continued to gain. Traditional American share of the passenger car market fell from 60.9% in the third quarter of 1989 to 57.4% in the third quarter of 1990. Japanese imports' share fell from 20% to 18% over the same time period, but transplants rose from 1.4% to 16.8% of the total market.

Detailed automotive sales and production data is available from *Fast Track News*. Call 215-687-1559.

Dr. Thomas O'Grady is president and chief analyst of Integrated Automotive Resources in Wayne, PA, and publisher of Fast Track News.

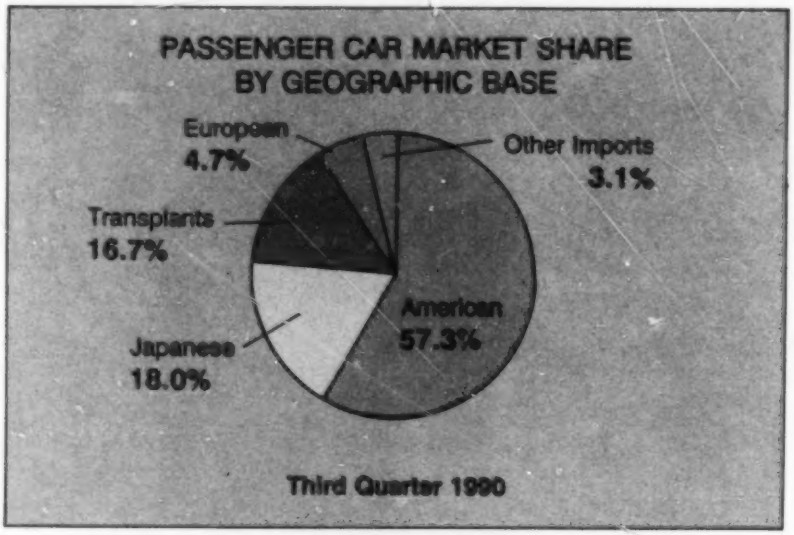
WHAT'S HOT!
Domestic Auto Sales
3rd Quarter 1990

Carline	'90	'89	% Change
Accord*	114,257	96,907	17.90%
Camry*	78,531	73,957	6.18%
Escort	74,491	98,767	-24.58%
Taurus	74,365	87,087	-14.61%
Cavalier	71,748	76,010	- 5.61%
Corsica/ Beretta	69,406	80,572	-13.86%
Civic*	60,558	52,906	14.46%
Corolla*	57,358	56,747	1.08%
Tempo	55,289	53,729	2.90%
Lumina	52,976	37,384	41.71%

* – Includes imports

US Passenger Car Market Shares
3rd Quarter, 1990

Manufacturer	'90 Sales	% Total	'89 Sales	% Total	% Change
General Motors	837,240	35.53%	928,037	35.33%	-9.78%
Ford	489,434	20.77%	586,327	22.32%	-16.53%
Honda/Acura	221,692	9.41%	209,518	7.98%	5.81%
Chrysler	206,171	8.75%	263,127	10.02%	-21.65%
Toyota/Lexus	202,657	8.60%	190,001	7.23%	6.66%
Nissan/Infiniti	122,202	5.19%	136,174	5.18%	-10.26%
Mazda	61,368	2.60%	63,116	2.40%	-2.77%
VW/Audi	40,525	1.72%	36,786	1.40%	10.16%
Hyundai	33,853	1.44%	47,752	1.82%	-29.11%
Subaru	32,223	1.37%	37,451	1.43%	-13.96%
TOTAL CARS	2,356,211	100%	2,626,823	100%	-8.18%



Passenger Car Market Share By Geographic Base

Third Quarter 1990

Manufacturers	Total Sales	Total Market Share
American	1,351,257	57.35%
Japanese	424,607	18.02%
European	112,056	4.76%
Transplants	395,049	16.77%
Other Imports	73,242	3.11%
Total Cars	2,356,211	100.00%

3RD QUARTER 1990 DOMESTIC LIGHT TRUCK PRODUCTION*

COMPANY	FULL-SIZE TRUCKS	COMPACT TRUCKS	FULL-SIZE VANS	COMPACT VANS	FULL-SIZE SPORTS UTILITY	COMPACT SPORTS UTILITY	TOTAL 1Q '90	TOTAL 1Q '89
FORD	132,663	59,230	38,219	52,519	10,643	62,064	355,338	300,798
CHEVROLET	130,697[1]	48,609	21,628	50,848	28,061	41,780	321,823	336,956
GMC	35,588[1]	11,980	7,986	11,694	11,423	13,503	92,174	107,677
CHRYSLER/ DODGE	24,520	16,439	15,802	41,085	—	—	97,854	155,247
JEEP	—	2,306	—	—	1,489	41,475	45,270	70,881
NISSAN	—	27,830	—	—	—	—	27,830	25,965
OLDS	—	—	—	5,633	—	—	5,633	737
PONTIAC	—	—	—	7,640	—	—	7,640	1,398
ISUZU	—	4,531	—	—	—	6,769	11,300	990

[1]Includes Suburban and P-model. *Built in the US and Canada.

CHILTON'S

AUTOMOTIVE INDUSTRIES

DECEMBER 1990

IS FORD SLIPPING?

THE PEOPLE — THE PRODUCT — THE PROCESS

HONDA'S TOUR DE FORCE

1991 Acura NSX

AUTOMOTIVE INDUSTRIES ANNUAL ENGINEERING AWARD

Acura's NSX takes the prize. Page 30.

Volume 170, No. 12 December 1990

CHILTON'S AUTOMOTIVE INDUSTRIES

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We pick the standout engineering effort for 1990.

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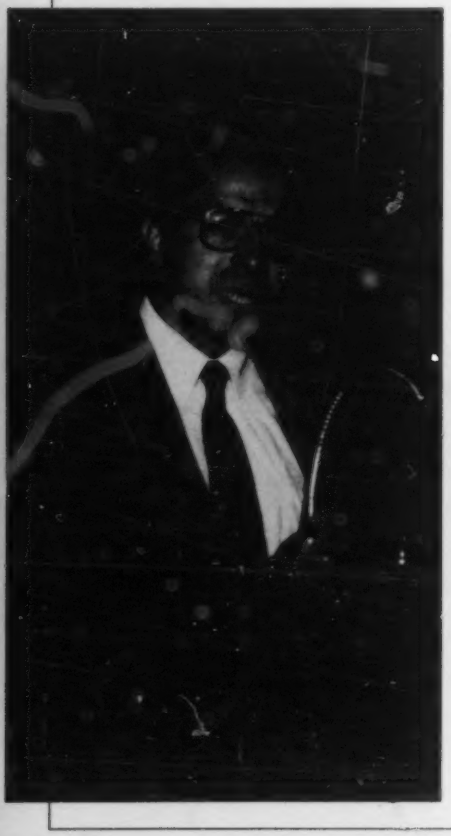
PRESIDENT

1990 SAE CONVERGENCE SHOW

Good things come in small packages, they say. And that certainly applied to the SAE's Convergence Show on automotive electronics. Though small – total attendance was 3300 people – it was the kind of show where you could see everything, whether attending technical conferences, touring exhibits, or catching the keynote speeches. Just in case you didn't make the show, here are some of the highlights.



Harold Poling
Chairman, Ford Motor Co.

Ford's chairman, "Red" Poling (right), predicts that on-board electronics will become totally integrated by the late 1990s. After that, he says, will come the electronic integration of the car to its environment, where cars will virtually drive themselves. "For a guy who's first car was a Model A, when the hottest option going was the quail radiator cap, this is pretty amazing," Poling said.

Other electronic-related news from Poling:

- *Ford is building more dynamometers in the US, UK and Germany to prove out electronic powertrain and chassis systems more quickly.*
- *Ford is expanding its scientific research lab in Dearborn to develop silicon-based sensors.*
- *Ford, Mazda and Sanyo will form a joint venture to design, develop and manufacture automotive audio products. Ford will get radios for vehicles primarily sold in the Asia-Pacific region.*

Poling called for the industry to develop a multiplexing standard. And he noted the need to coordinate IVHS activities in the US, Europe and Japan to eliminate duplication of effort – especially to avoid wasting engineering talent, which is in critically short supply worldwide.

George Fisher
Chairman & CEO, Motorola

The most oft-heard phrase at Convergence 1990 was "time to market." Motorola believes rapid response to market needs is critical for success. "We need to do business in a world without boundaries," says Motorola's chairman George Fisher (left).

If you overspend your budget 50% to bring a new product out six months early, he says, it will only hurt pre-tax profits by three to four percent. On the other hand, he claims, if you hit your budget but come out six months to one year late, pre-tax profits can fall by as much as 33%.

Fisher used a pager factory Motorola has in Florida as an example of how it is geared to respond quickly to customer orders. Within 17 minutes of receiving an order, a bar code with all the customer's requirements is being affixed to a printed circuit board. Two hours later, it's being shipped.

"Why not have a car with custom features that can be delivered to the customer in less than one week?" Fisher asked. "Those possibilities are not out of the realm of possibility." The problem is getting rid of the bureaucracy and paperwork.

(P.S. Motorola is not a new name to the auto industry. The company started making radios for automobiles in the 1930s. In fact, the company's name comes from a combination of "motor car" and "Victrola.")

Allesandro Barberis
President & CEO, Magneti Marelli

Who has the best automotive electronic technology? Alleasandro Barberis (left) divulged his company's competitive assessment of where the Japanese, Americans and Europeans stand.

In powertrains, he admitted the Europeans trail both the Americans and Japanese. The reason is that European emission controls have not been as stringent as they are in the US or Japan. But that will change soon, he said.

In the area of safety and controls the Europeans are also behind because their approach is through active, not passive safety (such as airbags).

Europe also lags behind in electronic entertainment and communications. But in the area of electronic temperature control, Europe is coming on strong. And when it comes to Prometheus-type technology, he says Europe is even with Japan and ahead of the US.

Overall, Barberis said Europe owes a great debt to the US and Japan in the area of semiconductors. In memory devices he rates Japan as best; the US in microprocessors; the Europeans in smart power, sensors and actuators.

Despite Europe's debt to the US and Japan, Barberis believes Europe is catching up fast. He is especially bullish about the European government sponsored program, called JESSI, for common R&D in sub-micron technologies. And European companies will short-cut the catch-up process with technical agreements with Japanese companies, he predicts.

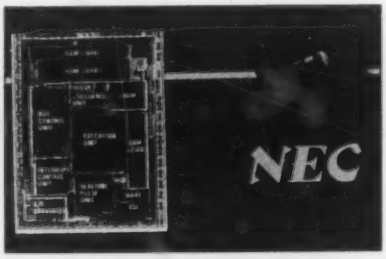
Koji Kobayashi
Chairman Emeritus, NEC

Compared to the recent past, we now live in a world of "no inconveniences," says Dr. Kobayashi (below). He reminisced that as plant manager of NEC's largest telephone manufacturing plant in Japan in the late 1940s, he didn't even have a telephone in his own home.

Dr. Kobayashi believes that the industry will soon be turning to satellite technology to locate a car's position, control traffic, and locate the nearest available parking space. He believes the automatic location of parking spaces will be available in 10 years.

NEC K-3 Series Semiconductor

NEC introduced its 16-bit K-3 series semiconductor (above right) at Convergence. The company claims its unique architecture makes this chip ideal for ABS, traction control, even engine control – though NEC doesn't expect the latter to find any application in the US.



The K-series features what NEC calls a peripheral management unit (PMU). Most chips spend 80% to 90% of their time transferring input/output information, says NEC, creating an I/O bottleneck. But on the K-series, the PMU handles the transfer of information. This means the CPU only spends 30% of the time transferring information, allowing it to run faster. In turn this means more peripherals can be added, allowing the CPU to process more data – up to 55 I/O ports.

The K-3 series has an 8-bit external bus. NEC says this chip would allow an automaker to put all of its chassis controls onto one chip.

The PMU is etched right into the silicon, so it reduces system cost by eliminating discreet ICs. In 10,000 piece orders the price of the K-3 is $10 to $15 per chip. Sometime in 1991 NEC will begin manufacturing the chip at its Roseville, CA lab.

NEC is also expected to introduce its K-6 series in the near future. The 16-bit chip, with its 16-bit bus will get close to DSP capabilities, the company claims. It will primarily be aimed at engine controllers and will be priced at $15 to $20 per chip in 10,000 order quantities.

Nagayuki Marumo
Executive Managing Director, Nissan

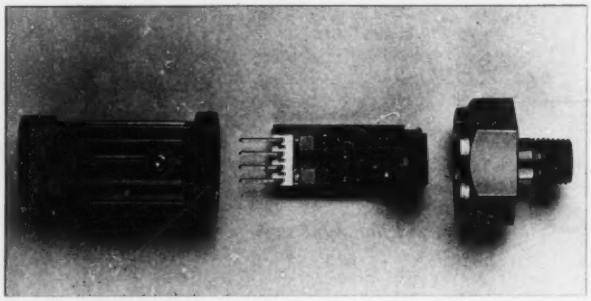
In a private interview with Automotive Industries *at Convergence '90, Nagayuki Marumo gave us some of his views on the automotive electronic industry:*

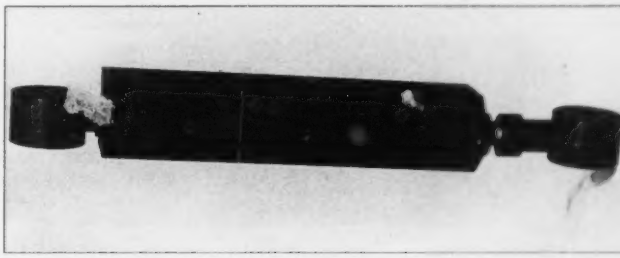
- *"The growth of automotive electronics will accelerate in the 1990s. The reasons for this will primarily come from the information technology that will be incorporated into vehicles, especially digital cellular telephones and navigation systems. As a result, the man/machine interface will become more natural."*
- *"Nissan has introduced a radar system for obstacle detection on large commercial trucks in Japan. It's not a microwave radar, it's a laser radar. When you get too close to the vehicle in front of you, it emits a warning. The next step is to have it automatically do the braking. But it's only on commercial trucks because it costs between $100,000 and $200,000. At the Nissan Central Research Lab we are working on a similar system for the blind spot at the side of the car where the warning will be displayed on the inside rear-view."*
- *"We think our magnetic navigation system will be one of the finest in the world. We have very precise software for map matching to compensate for errors. And we can improve this system in the coming decade, especially using GPS [global positioning satellites] as an assist. We tried using Loran-C at the Tsukuba Science Fair some years back, but were not satisfied with the results. It only has 300 meter accuracy. But, could GPS be closed off to public use during a war? This is a personal concern I have."*
- *"We believe automakers should do their own integrated circuit design in-house. And they should learn the processing, too. The reliability in electronics is critical, and there are many manufacturing factors that affect reliability. We must know everything about IC and LSI design and processing. The quality of electronics in the car is bad because we rely on the battery, so there are big electric spikes. As a result, we need very tough ICs, which require special processing*

Continued on p. 44

Acustar Electronic Oil Pressure Sensor

Acustar designed this generic electronic oil pressure sensor (EOP) (below) with all OEs in mind, not just Chrysler. Indeed, Chrysler may not be Acustar's first customer for it. The EOP features a piezoelectric sensor that converts pressure to electricity, which is then filtered and amplified for output to a gauge or lamp. Acustar sees a potential market for five million EOPs, but initial production in Huntsville, AL will start at 200,000 a year.





Nartron's New Position Sensor

Nartron Corp, of Reed City, MI, introduced a solid state, non-contact sensor called the Nartron variable Integrating Transformer (NvIT) (above). A custom output vs. position response can be "built" into an NvIT. This means that non-linear characteristics of a system requiring a position and/or speed measurement can be compensated for directly in the sensor, without the cost overhead of analog or digital computational electronics, says Nartron. The low cost NvIT is said to be ideally suited for adaptive suspensions, as well as other position and motion sensing applications.

Continued from p. 43

techniques. The IC makers don't like to change their processes, so they don't produce ICs that are optimal for automotive use, so we use commercial-grade ICs. There are some special ICs where we are doing the design and process design. We are starting to make chips to withstand high temperatures in the engine compartment, for multiplexing in doors and the IP, and we're doing switching ICs. Plus, we have other special ICs we are designing."

- *"At present we prefer silicon rather than gallium arsenide. Gallium arsenide has high-speed calculating and it can take high temperature, but the cost is very high. It's very unstable and has a high manufacturing reject rate. I think we'll have to study using GA if we use chips in the engine compartment or for high-speed processing. But this is something the electronics industry should develop for the automotive companies."*
- *"We're very interested in the application of fuzzy logic. We're developing it for cruise control to maintain the proper distance between vehicles. Fuzzy logic will become very important to achieve a natural man/machine interface. It is most important for the driver to feel comfortable. However, even fuzzy logic can't match the delicate control the human brain provides. But by the end of the decade we'll have supercomputers installed in the vehicle with one hundred times the speed today's supercomputers have."*

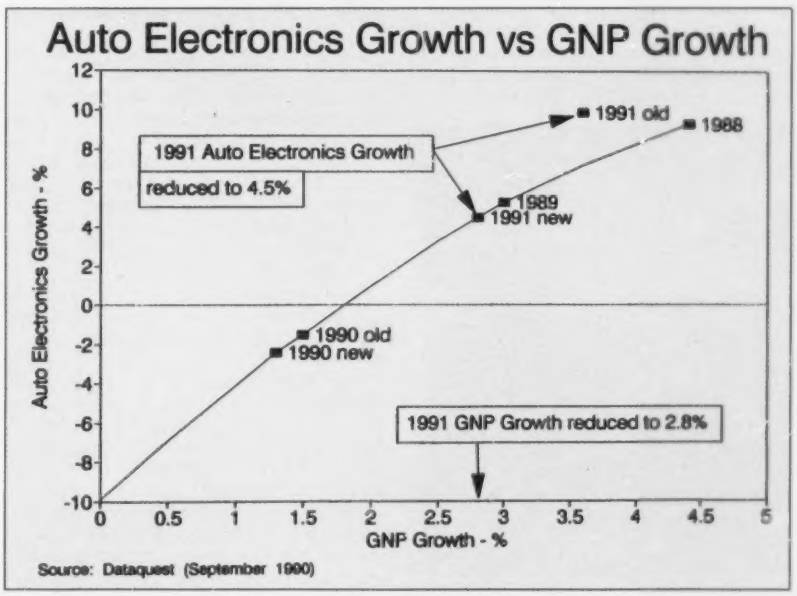
Jack Shaw
Chairman, Hughes Network Systems

By 1992 all US highways will have cellular coverage, says Jack Shaw, chairman of Hughes Network Systems. Now the big push should be converting to digital cellular phones. With the analog phones we have today it's fairly easy to listen in on conversations, he says. If you drive the same route everyday it's especially easy for someone to track down your calls. But digital, by its very nature, is much easier to make secure.

Beyond that, says Shaw, we should be looking at expanding personal communications. Portable cellular phones are one avenue. But he talked about having your own personal telephone number, possibly your social security number. Your phone calls would then be directed to the telephone nearest to you.

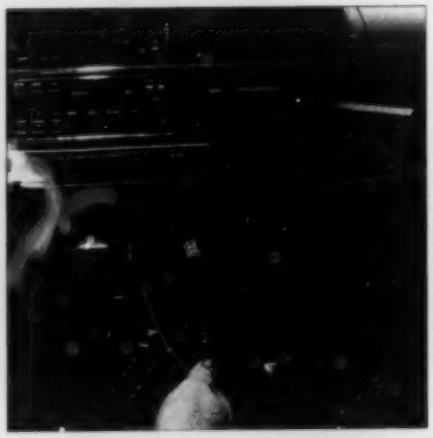
Dataquest Forecasts Downturn

Dataquest, the electronics forecasting firm, predicts automotive electronics growth will fall 10% to 4.5% in MY 1991. This will be partly caused by slow car sales, a shift towards smaller cars with less electronics, and increasing sales of transplant cars which use less electronics – for example, they don't have airbags or ABS.



Siemen's Ali-Scout

Perhaps the most effective IVHS demo at Convergence was Siemen's traffic management system called Ali-Scout (photo, next page). It's a Prometheus-funded navigation system that has been piloted in West Berlin for three years. With an on-board magnetic field sensor used for dead reckoning, a vehicle can keep track of its location. And with an infrared sensor located on the back of the inside rearview mirror, which communicates to beacons that would be mounted on existing traffic lights, a central computer system can keep track of Ali-Scout equipped vehicles.

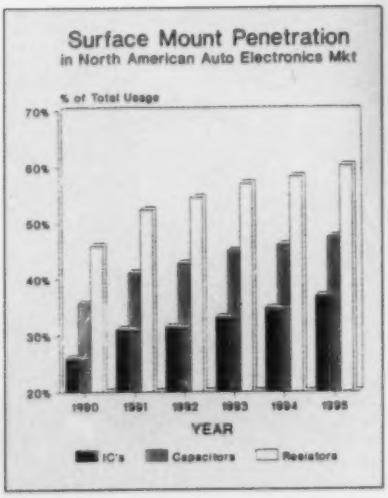


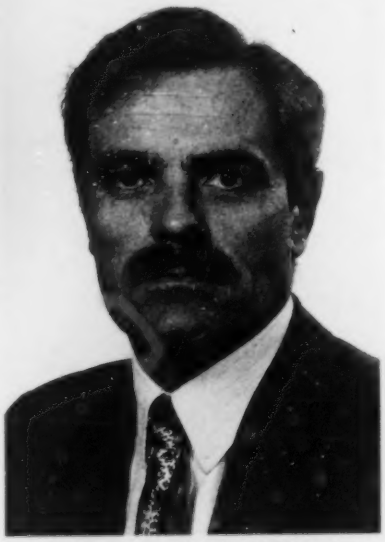
By programming your destination as x,y coordinates that are input from a hand-held remote, Ali-Scout will guide you to your destination. Directions to your destination come from both a directional arrow displayed on a small LCD panel (right center), and with voice directions that tell you which way to turn (speaker located directly behind rim of steering wheel).

With Ali-Scout, your directions to your destination would route you around traffic congestion. Siemens claims that based on the Berlin pilot study, if only 20% of vehicles used Ali-Scout, virtually all traffic snarls would be alleviated from metropolitan roads.

Surface Mount Devices To Grow

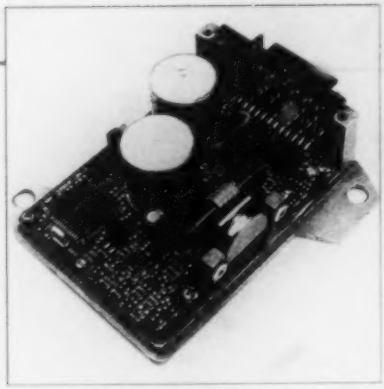
Surface mount devices will increase their penetration in automotive electronic systems through the mid-'90s, predicts M.H. Kitchen & Associates. Surface mounting refers to soldering electronic components directly to a printed circuit board (below), instead of pushing pins through holes in the board. Presently, surface mounting is more expensive than through-hole mounting, especially when low-cost off-shore labor is used. But prices of surface mounting are falling and will continue to do so as more integration and smaller packaging becomes more important, Kitchen predicts.





Convergence Appoints New Chairman

Bud Marx (above), executive director of Ford's Automotive Components Group, was appointed chairman of the 1992 Convergence show. He took over the reins from this year's chairman, Tim Leuliette, president of Siemens Automotive.



Bosch's Electronic Airbag Sensor

In the airbag field, Bosch remains true to the electronic, single-point sensor with its new Air Bag 6 (above).

AB6 can begin airbag deployment 20 milliseconds after the start of impact, claims Bosch; 50 ms after impact, the bag is fully inflated. An accelerometer and digital signal microprocessing (DSP) allow AB6 to monitor multiple crash parameters from a single point, and from within the passenger compartment. This central location eliminates external sensors, wires and connectors. The DSP's algorithm also includes multiple thresholds for belted and unbelted occupants.

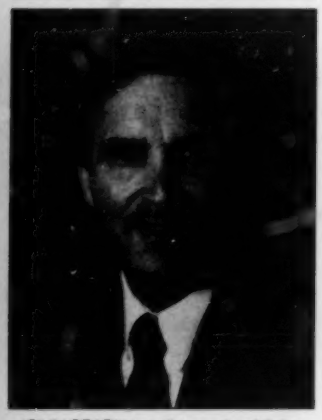
Other features include a Bosch-developed dual-element accelerometer instead of a safing switch, application-specific integrated circuits (ASICs or custom ICs), an energy reserve in case of vehicle battery failure, and a serial data link for diagnostics. AB6 weighs up to five lb less than electromechanical systems, says Bosch.

Analog Devices' Smart Sensors

Analog Devices and BMW have jointly developed a smart IC – the AD22001 (above) – that automatically detects failures in five lamp filaments, including headlamps. It detects a small threshold of 1.75 millivolts across a small shunt resistor in series with the lamp being monitored. Packaged in a 20-pin DIP, it consumes only 300 milliwatts of power and replaces a complex board-level design that carried over 80 discreet components. BMW will start using the lamp monitor in April 1991 on its 7-series cars. The AD22001 is available on the open market and is priced at $2 in quantity orders.

Analog Devices also announced it has developed a sensor that controls battery charging, allowing a higher charge in winter when more cranking power is needed, and less in summer when it's not. The sensor prevents the battery from overcharging. Presently, Analog Devices has no automotive customers for this sensor. AI

Excess Capacity...Again?



JOHN STARK is editor and publisher of Stark's Off-Highway Ledger in Chicago, IL.

Can heavy truckmakers prevent the excess capacity of the early '80s?

The downturn in the North American heavy truck business sounds like 'deja vu' to many industry officials. Truckmakers are once again faced with managing vital cash flow in a recessionary market. Hence, many firms are reassessing their current long-term use of assembly plant capacity.

Several companies are predicting that US and Canadian market demand for Class 8-type vehicles will recede to 140,000 units in 1990 and to 120,000 units in '91. Since heavy truckmakers are capable of building more than 176,000 vehicles per year at 10 plants in North America, production overcapacity obviously exists.

Some truckmaking officials believe heavy truck business may now be permanently overcapacitized by 20%. Perceived overcapacity could prompt the closing of one or more plants through 1991.

Assembly overcapacity is not new to the heavy truckmaking business. Prior crisis has restructured the industry. Foreign-based firms with deep pockets entered the market through corporate acquisition.

General Motors has been the industry's lowest user of heavy truckmaking capacity in place as late as 1988. It shed excess capacity late that year by permanently closing an assembly plant in Pontiac, MI, and spinning off its big truck business into a North American venture with Volvo of Sweden.

Mack Trucks, acquired by Renault Vehicles Industriels of France, has consistently ranked as the industry's second lowest user of capacity in place. Adverse financial repercussion of poor capacity use drove it into the waiting arms of Renault Vehicles.

Shortly afterward, Mack closed a truck assembly complex in Oakville, Ont., for three months and extended the plant shutdown for another three months due to an extremely weak Canadian market.

Volvo, which had previously ranked as the industry's third lowest user of available truckmaking capacity, sharply raised capacity utilization this year – even after it expanded truck assembly capability by 27% in 1989. Volvo opened a new production site in Orrville, OH, to handle increased market volume for Volvo GM joint venture trucks.

Other truckmaking companies are reasonably positioned to weather falling capacity use as market recession accelerates by keeping a tight lid on expansion plans.

For example, Navistar International used 117.9% of available capacity in 1989. Kenworth followed (108.6%), Peterbilt (107.8%), Ford (101.4%) and Freightliner (98.4%).

In 1990, production capacity use will be off for most manufacturers. Nevertheless, positioning within the industry should remain relatively unchanged. However, two truckmakers that have plans to add capacity may have to move those plans to the back burner.

Kenworth still plans to add another truckmaking site to its production network, replacing an aging facility at Seattle, WA. And Freightliner may open a fifth truckmaking complex in eastern Canada.

Ford, meanwhile, recently moved to consolidate truck assembly capacity at Louisville, KY, by relocating the output of Cargo-model midsize vehicles to the plant from a site in Brazil. Freightliner will close a medium-duty truck production facility at Hampton, VA, later this year and shift assembly to a complex in Cleveland, NC.

Heavy truckmakers appear determined to prevent the capacity woes of the early 1980s from repeating itself. Excess capacity is being reined in through astute asset management activity. Yet, one or two more plants may be permanently closed before it wins the latest round with market recession. ■

North American Heavy Truckmaking Capacity

	1990	1989	1988	1987	1986
Mack	38,000	38,000	38,000	38,000	46,000
Freightliner	33,000	28,000	28,000	28,000	28,000
International	30,000	30,000	30,000	30,000	30,000
Volvo GM	23,000	23,000	17,000	17,000	17,000
Kenworth	19,000	19,000	19,000	19,000	19,000
Peterbilt	17,000	17,000	17,000	17,000	17,000
Ford	16,000	16,000	16,000	16,000	16,000
General Motors	--	--	21,000	21,000	21,000
Total	176,000	171,000	186,000	186,000	194,000

C2150-3

DETROIT AUTO SHOW!

CHILTON'S

FEBRUARY 1991

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THE PEOPLE – THE PRODUCT – THE PROCESS

1991 MAN OF THE YEAR

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Volume 171, No. 2 February 1991

Cover portrait of 1991 Man of The Year John F. Smith, Jr., by Randy Hamblin

CHILTON'S
AUTOMOTIVE INDUSTRIES

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STOCK SHOCK

Hard times in Detroit had a powerful impact on the personal stock holdings of Big Three executives in 1990.

by JOSEPH M. CALLAHAN

A combination of the Persian Gulf crisis, Japanese sales inroads and the apparent US recession have caused a substantial reduction in vehicle sales and production for American automakers. Less conspicuous, however, are the major declines in the prices of GM, Ford and Chrysler common stocks.

Naturally, this has greatly diminished the personal assets of many officials at the Big Three. This situation has also resulted in serious financial losses for tens of thousands of lower-ranking 'white collar' workers, many of whom count on their securities as the foundation for their retirements.

During 1990, the price of common stock for GM stockholders declined from 42 1/4 to 34 3/8. Ford stock nosedived from 43 3/8 to 26 5/8. Chrysler stock dropped from 19 to 12 5/8, following a nearly two-point rise following Kirk Kirkorian's December purchase of over 9% of Chrysler stock.

Percentage-wise, the declines were 18.6% for GM shares, 39% for Ford securities and 33% for Chrysler stock. GM's E and H securities are not included in this report.

William Clay Ford, a director of Ford Motor Co. and the only surviving grandson of Henry Ford, was the automotive industry's largest loser last year. He owns more than eight million shares of Ford stock. The $16.75 loss per share produced a total loss for him of about $135 million.

The officers and vps of GM, Ford and Chrysler hold the following shares of stock either directly or indirectly, according to the Securities and Exchange Commission and various published data:

FORD MOTOR CO.	
William C. Ford, director	8,088,649
Edsel Ford, director	1,281,426
Donald Petersen*	185,381
Harold [illegible]ding, chairman	166,329
Louis Ross, exec. vp	75,829
Donald McCammon, vp	64,984
Louis Lataif, vp	50,013
Philip Benton, president	49,779
Peter Pestillo, vp	39,393
Edward Hagenlocker, vp	16,772
John [illegible] Courter, secretary	16,387
Melvyn Ma[illegible]ing, vp	5,611
John Hausm[illegible], vp	5,258
John W. Martin, vp	3,982
Clifton Wharton, director	3,900

Retired
*1990 Proxy Statement

CHRYSLER MOTORS

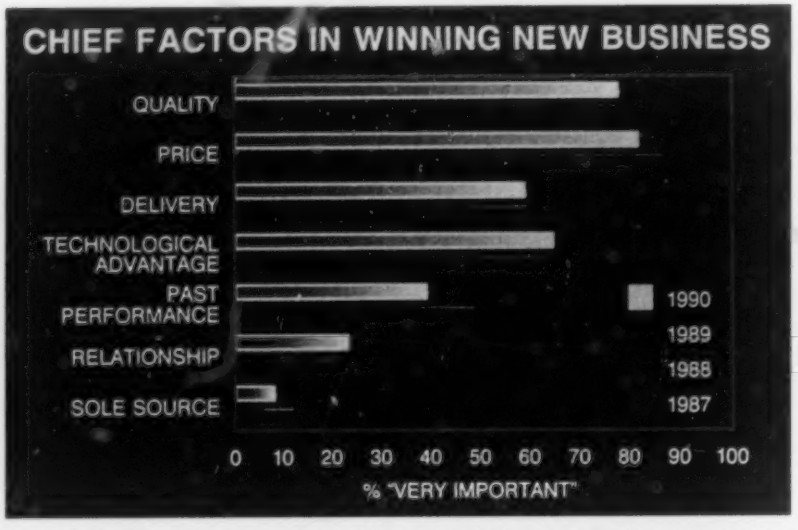
GM

CHRYSLER CORP.	
Lee Iacocca, chairman	382,491
Gerald Greenwald	47,649**
Robert Miller, exec. vp	31,066**
Bennett Bidwell	23,913**
Ronald Grierson, director	15,200
Glenn White, vp	15,000
Thomas Denomme, vp	12,145
Robert Lutz, president	7,058**
Joseph Cappy, vp	6,905
J. Paul Sticht, director	5,875
Francois Castaing, vp	4,986
Anthony Bryan, director	4,700**
Peter Magowan, director	4,450**
Malcolm Stamper, director	4,018**
Arthur Liebler, vp	2,822
Lilyan Affinito, director	2,250**
Joseph Califano, director	2,250**
Leroy Richie, vp	1,969
Joseph Antonini, director	1,500
A.J. DeGrande, director	1,325
Kent Kress, director	1,200
Earl Graves, director	1,000**
Robert Lanigan, director	762
Juanita Kreps, director	747
William Milliken, director	450
*Retired **1990 Proxy Statement	

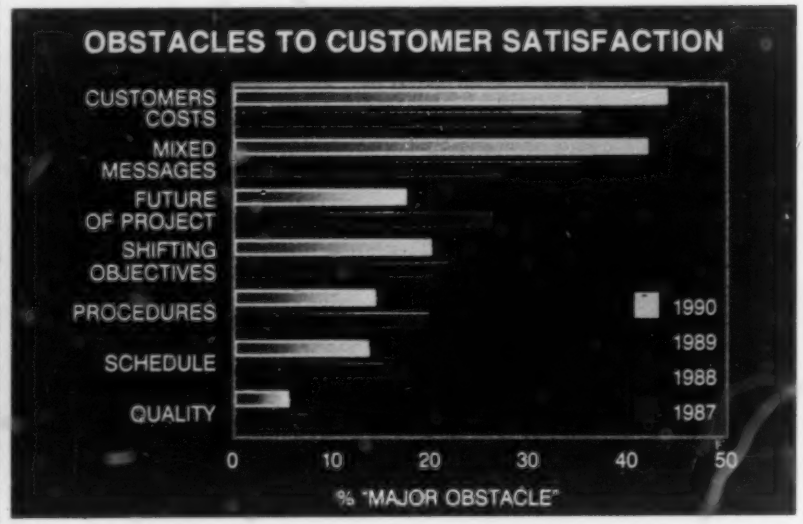
GENERAL MOTORS	
Lloyd E. Reuss, pres.	64,310
Edward Czapor, vp	53,020
Robert Stempel, chair.	46,075**
Patrick J. Coletta*	45,787
David Campbell, vp	39,638
Charles Moore, vp	38,846
Charles Kafko*	34,207
Robert O'Connell, evp	31,928
John McNulty*	31,036
James Johnston, vp	30,794
George Peapples, vp	29,652
John Smith Jr., v-chair.	29,651
J.T. Battenburg, vp	29,296
William E. Hoglund, evp	24,833
Robert Evans, director	24,808
John Rhame, vp	19,387
F. Allan Smith, exec. vp	18,636
John Grettenberger, vp	15,114
Ronald H. Haas, vp	14,880
James FitzPatrick, vp	14,880
Leon J. Krain, vp	14,827
Robert Schultz, v-chair.	14,685
Paul Zalecki, vp	14,116
Edward Mertz, vp	13,143
Betsy A. Johnson, vp	13,111

Michael Mutchler, vp	12,267
William Lane*	12,112
John Middlebrook, vp	9,297
Arvin Mueller, vp	8,940
Walter Binns, vp	6,827
John Jarrel, vp	6,358
Robert Stone, vp	5,383
Thomas McDaniel, vp	5,227
George Eads, vp	4,672
Lewis Campbell, vp	4,335
Charles Jordan, vp	4,332
John Michi, director	4,122
Charles Golden, treasurer	3,792
Donald Runkle, vp	1,583
Harry Pearce, vp	1,309
J. Trevor Eyton, director	1,000
Shirley Young, vp	987
*Retired **1990 Proxy Statement	

AUTOMOTIVE SUPPLIER SURVEY



"Price" has displaced "quality" as the chief factor in winning new business. Having a technological product advantage continues to increase in importance and is now the number three factor. A supplier's past performance with a customer is declining in importance, as has personal relationships with customers.



Customers' cost constraints still rank as the major obstacle to satisfying customers in current business dealings. Dealing with customers' "mixed messages" continues a four-year increase. Meeting customer's quality requirements continues to decline as an obstacle.

Four-year study shows suppliers nearing a profit crisis.

*Each year since 1987, Sandy Corp. – a major Detroit-area consulting, training and communicating firm – has conducted a survey of automotive suppliers, identifying key issues, concerns and trends in this industry. Through special arrangements with Sandy Corp., **Automotive Industries** offers these study highlights. The most recent study, conducted in November and December 1990, was based on responses of 138 supplier executives, equally divided between senior management and marketing roles. These respondents averaged 20 years' experience in the industry. Mean sales for their organizations were $1.128 billion.*

The Profit Crisis

During the last four years, quality-related issues were the top concern of automotive suppliers. Today, quality has been replaced by a "profit crisis," which suppliers see as a threat to their survival.

"Nearly two out of three suppliers said that profit erosion in 1990 has been 'significant' to 'very significant'," says Steve Wells, Sandy Corp. vp, who conducts the study. "For the fourth consecutive year, 'Assuring a profit and a return on investment' was their number one concern."

Wells says that both price and cost surface as key issues throughout the study. "'Price' has replaced 'Quality' as the top factor in winning new business," he explains. "Similarly, 'Cus-

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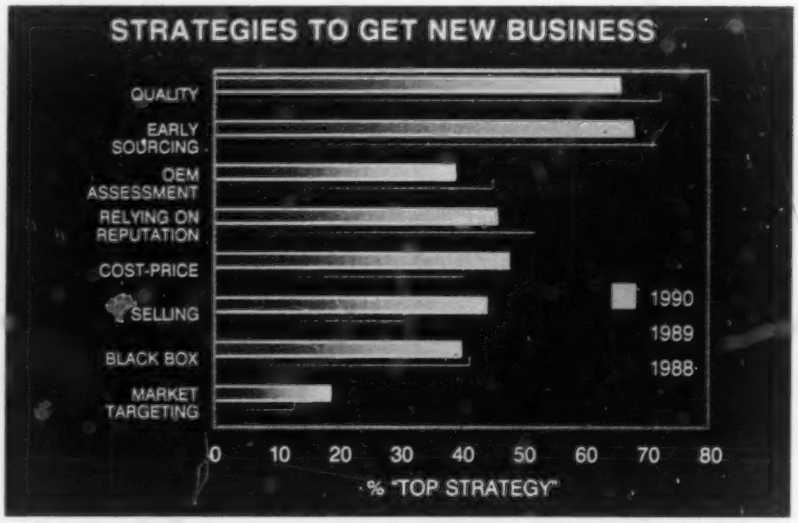


"Having a recognized quality reputation" continues a three-year decline as the top strategy to get new business. Instead, suppliers view "partnering" effectively with customers in early-sourcing design and development work as the top strategy, but even this declined in 1990. In fact, nearly all the traditional strategies have declined – becoming certified, relying on a positive reputation. Increasingly preferable strategies in 1990 were: attacking costs and responding to customer pressure to further reduce prices; and maintaining good marketing contact with potential customers by a knowledgeable sales force.

Once again, early sourcing is perceived as the strategy with the greatest impact to improving quality and lowering cost. But this declined in 1990. Increasing significantly was implementing comprehensive quality improvement programs, such as QFD. Once again, automakers' supplier certification programs seem to have lost favor as effective mechanisms to gain increased quality at lower cost.

tomers' cost constraints is the number one obstacle to customer satisfaction for suppliers."

The study also indicates that customer's "high overhead costs" appears to be increasing as a customer practice that has a serious effect on suppliers.

Consequences of Profit Erosion

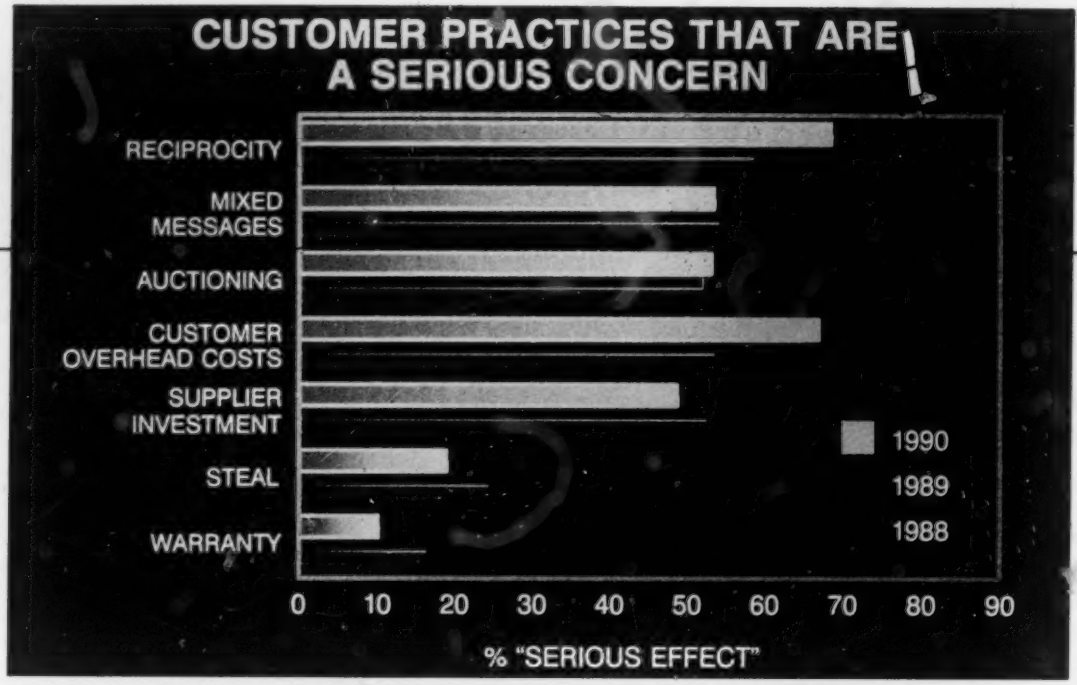
Suppliers believe profit erosion will have its most serious effect in the amount of technology and innovation they can offer the automakers, and in the degree of services and support they can provide. Most suppliers feel the key to increased profitability lies within their ability to implement internal productivity and control other costs.

Other results show that suppliers are increasingly concerned about getting what they interpret as "mixed messages" from their customers. Being able to "partner" effectively with customers in early sourcing relationships, though still viewed as a highly effective strategy by suppliers, is declining as the strategy of choice, as are automakers' supplier assessment and certification programs.

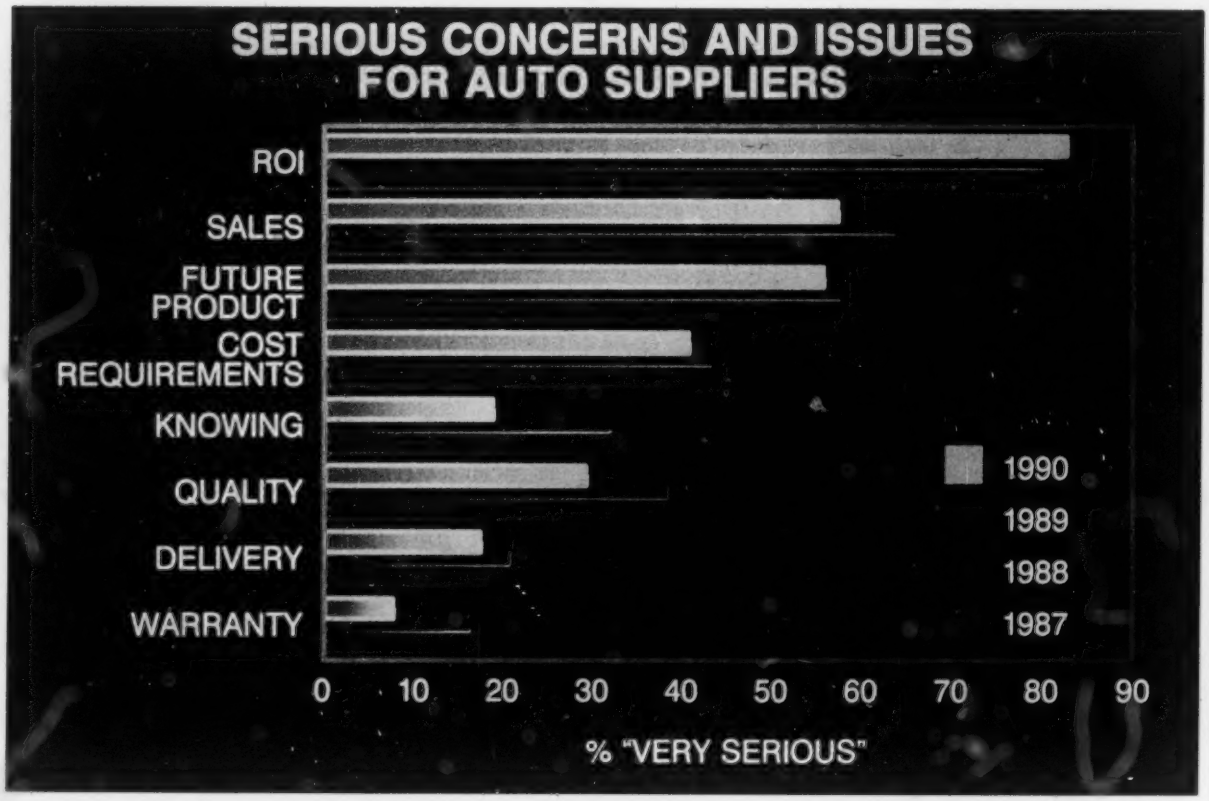
Looking Internally for Answers

Suppliers appear to be turning internally for answers, whether beefing up marketing efforts, restructuring organizations, developing joint ventures or increasing efforts to launch overall quality approaches within their organizations.

Their interest in training employees to address these new needs increased significantly in 1990. Suppliers gave highest priority to teamwork training, whether internally across disciplines, or to work better as "partners" with customer personnel. There was also increased interest in training new quality assurance techniques to technical personnel, and to train marketing and customer contact managers to market smarter and track customer expectations and satisfaction.



Suppliers still rate customers' lack of full "partnership" reciprocity in business dealings as the one practice that has the most serious effect, although 1990 shows a decline in this, and continuation of an increased concern over customers' high overhead costs and their resulting lack of profitability, which produces cost constraints passed on to suppliers.



Assuring a profit and return on investment continues to gain as suppliers' most serious concern, followed by assuring a flow of new business ("sales"). Other concerns have diminished in 1990.

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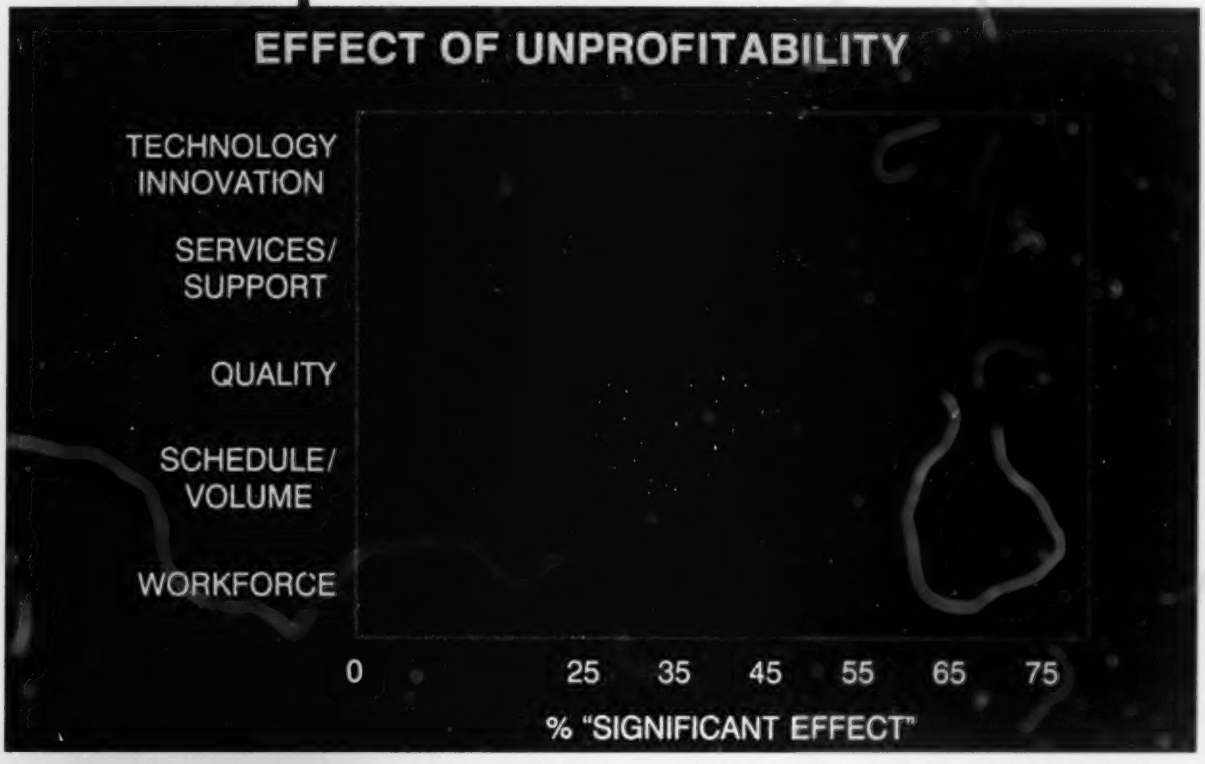
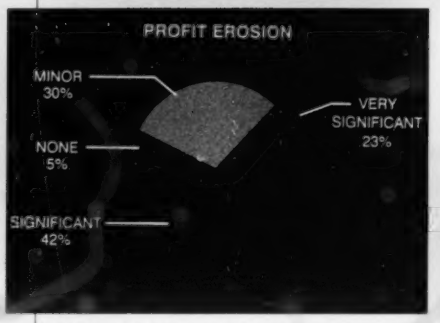
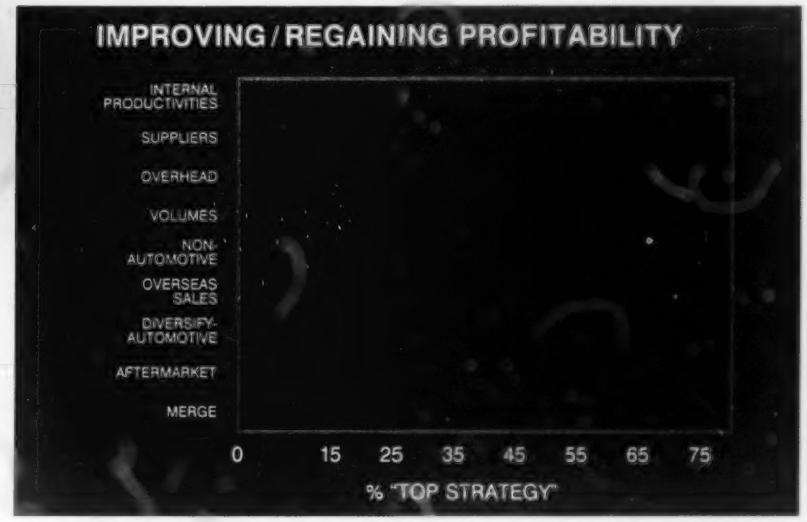
SUPPLIER SURVEY



Most suppliers feel that the amount of technological innovation they can bring to the table will be the first victim of unprofitability, followed by the level of services and support they can offer their customers. More than a third indicate that lack of profitability will have a serious effect on quality and also upon suppliers' capacity and schedule to respond to customers' schedule and volume changes. The competitiveness of suppliers' workforces will be the least affected, they say.



Nearly one in four suppliers reports "very serious" profit erosion over the past two years. Another 42% feel that erosion has been significant. Only 33% report profit erosion has been minor or none.



Suppliers clearly favor cost-reduction strategies as their top choices to improving or regaining profitability: achieving internal productivities through lowering the cost of production, reduce the cost of incoming materials ("suppliers"), reduce overhead burden. Increasing volumes with current customers is viewed by more than a third of suppliers as a top strategy. Others – seeking overseas markets, diversification within or outside of automotive, expansion into automotive aftermarket, mergers – are all seen as less desirable.

Complete results are available from Steve Wells, Sandy Corp., 1500 Big Beaver Road in Troy, MI 48084, 313-649-0800. Sandy Corp. offers a series of 1½-hour "Executive Briefings," scheduled in late February 1991 to present and explain the results. There is a modest charge for these sessions. For information and reservations, call Yvonne Juszkiewicz at Sandy Corp. AI

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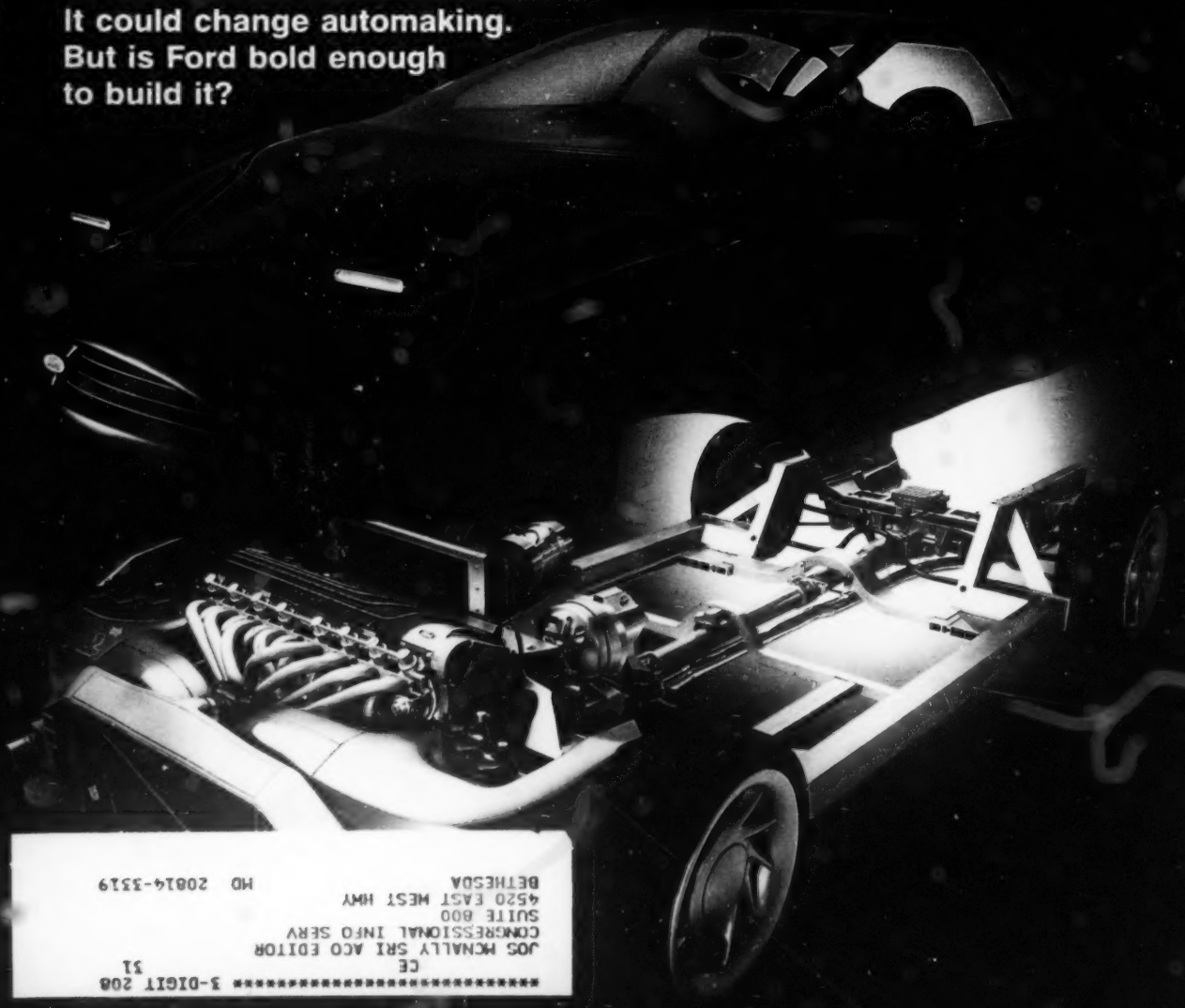
MARCH 1991

AUTOMOTIVE INDUSTRIES

THE PEOPLE — THE PRODUCT — THE PROCESS

THE CASE FOR CONTOUR

It could change automaking. But is Ford bold enough to build it?



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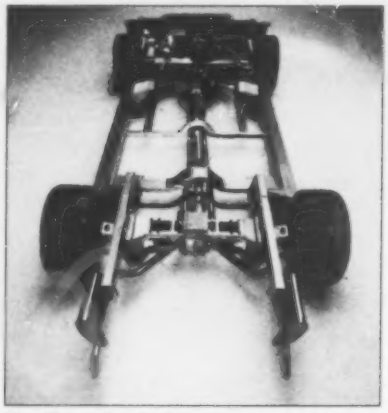

Ford's radical Contour could change automaking. See page 24. Cover photo by Jay Asquini

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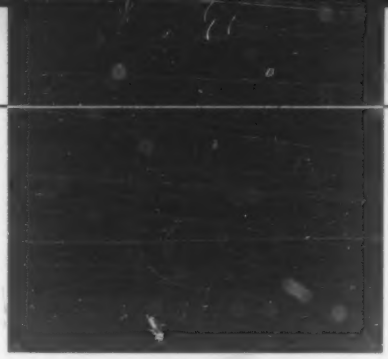

Japan To See Record Output Drop In '91

The Japanese automotive industry, faced with the prospect of declining demand in both the domestic and US markets, this year is expected to see its first drop in production since 1987.

According to a recent forecast by Kleinwort, Benson International, total vehicle output will fall by 4.3% to 12.8 million units, the largest single-year decline since 1974. In 1990, the Japanese industry built nearly 13.5 million cars and trucks, up nearly 4% over 1989 levels. Stephen Usher, an industry analyst for Kleinwort, Benson projects a 2.2% decline in domestic Japanese demand; pass-car sales will be off by 1.8% to 5.01 million units, he says; truck and commercial vehicle sales will drop by 3% to 2.59 million units. Similarly, he predicts that Japanese exports will fall 5.1% to 5.45 million units. Looking at 1992, total Japanese vehicle production should rebound to just over 13 million units—about 9.55 million passenger cars and 3.45 million trucks. AJ

1990 JAPANESE DOMESTIC AUTO SALES
(minivehicles in parentheses)

Toyota	2,534,217	
Nissan	1,403,894	
Mitsubishi	710,766	(284,651)
Honda	679,086	(235,260)
Mazda	591,623	(88,538)
Suzuki	537,029	(498,609)
Daihatsu	492,687	(443,039)
Fuji	337,492	(257,307)
Isuzu	164,622	
Hino	62,374	
Nissan Diesel	39,775	
Others	172	(172)
Imports	223,923	
TOTAL	7,770,665	(1,802,576)

1990 IMPORTS TO JAPAN

WORLDWIDE TOTAL:	**223,923**	**(up 23%)**
US TOTAL:	**28,602**	**(up 50%)**
GM	8513	(up 18%)
Honda of America	7534	(up 60%)
Ford Motor	3393	(up 26%)
Mitsubishi (Diamond-Star)	2886	--
Ford Probe (Mazda USA)	2637	(down 20%)
Toyota (mostly Lexus)	2109	--
Chrysler	1432	(up 47%)
Others	94	--
GERMAN TOTAL	**137,442**	**(up 14%)**
Mercedes-Benz	38,844	(up 23%)
Volkswagen	36,770	(up 6%)
BMW	36,527	(up 10%)
Audi	16,691	(up 17%)
Porsche	4589	(up 12%)
Opel	4021	(up 52%)
BRITISH TOTAL	**19,653**	**(up 35%)**
Rover Group	14,004	(up 37%)
Jaguar/Daimler	3547	(up 34%)
FRENCH TOTAL	**14,018**	**(up 34%)**
Citröen	6117	(up 57%)
Peugeot	5414	(up 18%)
Renault	2481	(up 24%)
SWEDISH TOTAL	**13,707**	**(up 40%)**
Volvo	10,915	(up 53%)
Saab	2789	(up 6%)
ITALIAN TOTAL	**5933**	**(up 30%)**
Fiat Group	5485	(up 29%)
SOUTH KOREAN TOTAL	**1623**	**(up 64%)**
Kia (Ford/Mazda)	1619	(up 66%)

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CHILTON'S

APRIL 1991

AUTOMOTIVE INDUSTRIES

THE PEOPLE – THE PRODUCT – THE PROCESS

1991 INDUSTRY REPORT CARD

Product Info Update

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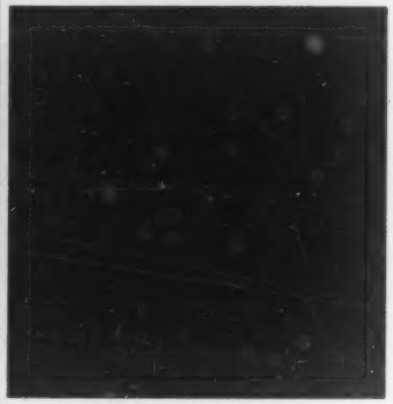

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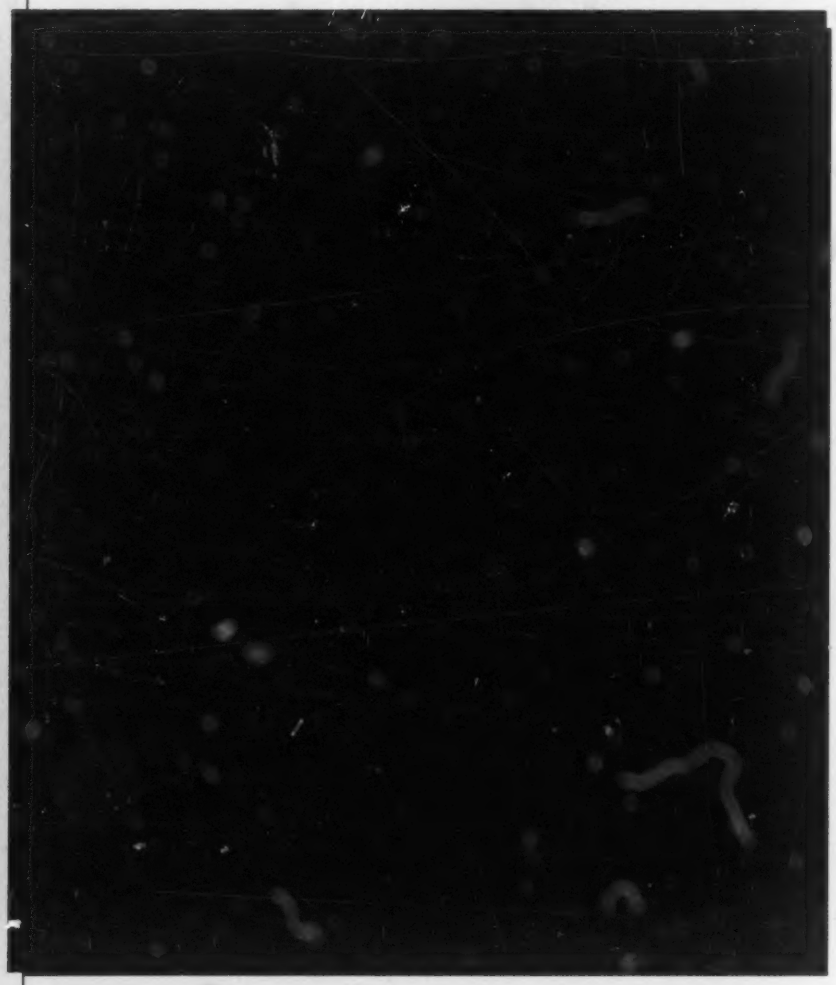
1991 INDUSTRY REPORT CARD

Tough times hit the Motor City.

by JOHN McELROY

Nineteen ninety was a tough time for the US automakers. A slowing economy, the high cost of sales incentives and growing import penetration all took a heavy toll.



Last year the US market fell 4.5% to 13.8 million units, the slowest sales – in recent times – since 1983. In a historical context, this is slightly more than the market reached in 1972, which was then a record year.

Total foreign-brand car and truck sales reached 3.93 million units – not a record sales year for them, though it did represent the highest market share (28.3%) they ever achieved.

The European makers slipped 4.9% to 455,800 units (though Alfa-Romeo, Mercedes-Benz and VW posted modest increases). The Koreans dropped 23% to 229,049 units. And the Japanese came out the big winners.

Japanese automakers saw their total sales in the US market increase 114,000 units to 2,586,100 vehicles. Interestingly, all of this increase came from transplant production, since vehicles exported from Japan to the US fell 10% to 1,525,500 units. Despite the overall Japanese increase Isuzu, Nissan, Subaru and Suzuki all saw their US sales decrease from the year before.

So how badly did the Big Three fare? To help you keep score, *Automotive Industries* once again presents the Industry Report Card. In it, each automaker is graded according to how it performed in six different categories that measure quality, profitability, sales performance, management proficiency, productivity and manufacturing efficiency.

We then compare each company against its past efforts, and sum it up with an overall grade.

(Continued on p. 32)

1991 REPORT CARD

GENERAL MOTORS CORPORATION

Category	1973	1978	1987	1988	1989	1990	Grade
Quality (defects/100)	–	–	176	165	158	149	A+
Profit/Unit	$490	$684	$435	$692	$645	($462)	F
Market Share	51.5%	47.3%	34.7%	34.9%	35.0%	35.5%	A
Return on Sales	6.7%	5.5%	3.5%	4.4%	3.8%	(1.6%)	F
Productivity*	11.4	12.1	11.3	12.9	12.6	12.0	C
Inventory Turns	5.4	6.7	18.0	18.8	20.0	19.3	B-

** = cars/employee/year*

OVERALL GRADE: C

GENERAL MOTORS CORP.

Quality: Our quality rating, which is based on J.D. Power's Initial Quality Survey (IQS), shows that GM reduced its defects per 100 vehicles by 5.7%. In fact, GM has nearly reduced its defects to Ford's level and could sail right past Ford in 1991.

However, almost all of GM's improvement has come from Buick, Oldsmobile and Cadillac – in that order. And Buick is truly the shinning star amongst those three. It now ranks fifth overall amongst all makes sold in the US, having moved past both Honda and Acura in the last year.

Profit/Unit: GM's profit per unit fell 170% from year ago levels. And 100% of this loss came from its US operations.

But GM's overseas operations performed spectacularly. Whereas GM lost over $1200 on every vehicle it built in the US, it earned $1000 on every vehicle it built overseas. This shows how important it will be for GM to try and protect the profitability of its overseas operations – especially those in Europe.

There were three significant reasons that caused GM to lose over $5.7 billion in the US. First, it took a $2 billion write-off for plant closings and other restructurings. That alone accounts for one third of its loss. Second, GM engaged in heavy sales incentives and rebates. Third, as sales fell so did productivity and that caused costs to rise.

Market Share: The good news is that GM picked up half a point of market share in the US. The bad news is that GM's total US sales fell by 171,500 units.

But even though GM's sales were down, they didn't fall off as much as the rest of the market. While the US passenger car market fell nearly 4.9%, GM only fell 3.7%. And while the US truck market fell 3.9%, GM's truck sales only fell 2.6%. That's how it picked up market share.

However, not every GM division was down. Chevrolet increased its passenger car sales compared to 1989, mostly due to the strong performance of the Geo line, especially the Geo Metro.

Return On Sales: By any financial measure, GM performed poorly in 1990. Its Return On Sales fell by more than 140% compared to the year before. Moreover, GM's costs as a percent of total sales are getting worse, not better. Costs and expenses increased by $2.3 billion in 1990. As a result, the new GM management team is taking drastic action.

The company has already announced it will cut 15,000 employees by the end of this year. That could save over $1 billion. It is also putting severe pressure on its suppliers to cut costs and prices by $2 billion a year. And to help free up more cash, the company cut its dividend nearly in half, which should provide management with well over $800 million in cash.

Productivity: GM slipped 4.7% in this category from the year before. But considering that its worldwide sales fell 5.7%, we're actually surprised that its productivity didn't fall off even more. This is why – even though GM has the worst productivity amongst the Big Three – we gave it a C.

Since the company is closing its "idled" plants, and will soon close some other plants, its capacity should come in line with demand. And that could provide GM with some substantial productivity improvements once the market rebounds.

Inventory Turns: GM's inventory turns fell off slightly compared to the year before. On a percentage basis they fell off less than did overall sales. This is a strong indication that the company is doing a better job of managing its manufacturing operations. With less inventory clogging the manufacturing process, quality is bound to improve. Indeed, that is borne out by GM's big improvement in the Quality category.

Will Saturn help GM increase its market share for 1991?

FORD MOTOR COMPANY

Quality: For the last eight years, Ford has been able to claim that it has the best built and designed cars in America, largely thanks to Lincoln's and Mercury's strong showing. But as our Quality rating shows, the company's overall defects per 100 vehicles actually increased 3.2% last year. And now General Motors is starting to breathe down Ford's neck. These figures sug-

(Continued on p. 34)

1991 REPORT CARD

FORD MOTOR COMPANY

Category	1973	1978	1987	1988	1989	1990	Grade
Quality (defects/100)	–	–	156	169	143	147.6	C-
Profit/Unit	$260	$360	$1023	$1014	$663	$53	D
Market Share	29.8%	26.5%	23.1%	23.7%	24.6%	23.8%	C-
Return on Sales	3.9%	3.7%	6.4%	5.7%	3.9%	0.8%	D+
Productivity*	13.7	13.8	18.7	19.9	19.6	16.5	D-
Inventory Turns	5.3	6.5	15.6	17.3	18.0	21.0	A+

** = cars/employee/year*

OVERALL GRADE: C-

gest that unless Ford gets the ball rolling soon, there could be a lot of red faces in Dearborn. So far, Ford's bragging rights to "Who has the best quality?" are heavily based on customer satisfaction at the dealer. That's important. But when independent surveys show your quality is starting to slip at the factory, that should send off alarm bells.

Profit Per Unit: Ford's profit per unit fell a staggering 92% in 1990. But at least the company managed to make money on all the cars and trucks it produced, something GM didn't manage to achieve.

The danger that Ford faces is that its European operations, which had been so profitable throughout most of the 1980s, are now only marginally so. Whereas Ford earned over $2 billion in Europe in 1989, it only earned $116 million there last year. And now the European market is facing the kind of overcapacity that is hurting the profitability of all automakers participating in the US market.

Market Share: Ford lost a lot of the market share momentum it gathered during the 1980s. And fully 30% of the downturn in its 1990 US sales was due to the disastrous launch of the new Escort and Tracer.

But there were some bright spots, too. Explorer went to the head of the sport utility class as sales jumped a whopping 66.7%. Sales at the Lincoln division rose a robust 15.6%, largely due to the overwhelming success of the Town Car. The Crown Victoria was rock solid. And despite the slow start, by year end the new Escort and Tracer were selling strongly. Other than that though, sales of every other car and truck in Ford's line-up went down.

Return On Sales: Financial results were a big disappointment for Ford in 1990. For every dollar that it took in at the cash register, it was only able to keep $^{8}/_{10}$ of a penny after it paid for all its expenses. And this came about even though Ford's financial services turned in a record performance, with $761 million in profits. As a result of the fall-off in profits, Ford eliminated all executive bonuses and did not make any profit sharing payments to its UAW employees for the first time since its profit sharing program was initiated.

Ford's Explorer proves that a great product can sell well, even in a down market.

Not surprisingly, Ford recently announced a worldwide cost cutting program to eliminate $3 billion by the end of 1991. Many analysts predict Ford will also cut its dividend, something that may have already happened by the time you read this.

Productivity: As sales fell faster than Ford (or anyone for that matter) could adjust to the fall-off, productivity suffered. This drop-off had an adverse impact on profitability, as is borne out in our Profit Per Unit category. Specifically, the company's productivity fell 15.8% from year-ago levels. This worsening of its productivity was partly due to the drop in sales, but Ford also increased its worldwide automotive employment level by more than 28,000 employees. Even so, it still managed to remain the most efficient of the US automakers.

Inventory Turns: Despite the drop-off in productivity and quality, Ford was able to dramatically improve its inventory turns, which are an indication of how well a company manages its assembly and production plants from a processing standpoint. Inventory turns improved 16.6% from year ago levels, which is all the more amazing, given all the negatives and uncertainties in the market place which the manufacturing people had to battle against.

CHRYSLER CORPORATION

Quality: After making a tremendous improvement in quality last year's report card, Chrysler slipped slightly in 1990. Though it didn't slip as much as Ford did, that's not much consolation when you're third in a race of three. Compared to all the makes competing in the quality race, Chrysler's divisions are grouped at the back of the pack. And whereas it's the luxury divisions that get high quality ratings at GM and Ford, the opposite is true at Chrysler. Plymouth leads the way followed by Dodge, Eagle and Chrysler. The

(Continued on p. 36)

1991 REPORT CARD

CHRYSLER CORPORATION

Category	1973	1978	1987	1988	1989	1990	Grade
Quality (defects/100)	–	–	178	202	169	172.5	D
Profit/Unit	$127	($129)	$853	$649	$249	$209	C
Market Share	15.6%	11.2%	12.3%	13.9%	13.7%	12.2%	D
Return on Sales	2.1%	(1.5%)	4.5%	3.0%	1.0%	0.2%	D+
Productivity*	13.0	13.1	16.2	18.0	19.5	15.7	D-
Inventory Turns	5.6	6.3	16.8	21.6	26.3	22.5	C-

** = cars/employee/year*

OVERALL GRADE: D

most disconcerting part of Chrysler's quality performance, however, is that it is up and down, year to year. This lack of consistency may be partly explained away as "noise" in the measuring methods. But the fact that Chrysler is going through this kind of roller coaster quality performance doesn't look good. Quality is an area where one expects consistency – and constant improvement.

Profit Per Unit: Chrysler may have slipped in the profitability area, but compared to the folks in Dearborn and Detroit, the ChryCo financial people look like rocket scientists. One area in which Chrysler greatly outperformed its crosstown rivals was with cost cutting. Whereas automotive costs increased $3.2 billion at Ford and $2.3 billion at GM, Chrysler drastically cut its costs by $3.2 billion. That kind of cost cutting went a long way to offset the $4 billion drop in sales that the company suffered. And it shows heads-up thinking on the part of Chrysler's management to cut spending so deeply and so quickly. Ford and GM are only now beginning to follow suit.

Market Share: Chrysler lost so much market share so fast in 1990 that it raises serious concerns about the company's future. It certainly risks losing being ranked as one of the Big Three. Chrysler's car sales fell three times as much as the total market did. Indeed, in passenger cars Honda came within 6000 units of outselling Chrysler. And unlike last year, Dodge trucks and Jeeps didn't help to offset some of the company's sales slippage in passenger cars. In fact, Chrysler's truck sales fell nearly four times as much as the total truck market did.

Return On Sales: No, Chrysler didn't do too well financially in 1990. Its return on sales fell 80% from year ago levels. But that doesn't tell the whole story. In 1989 the profit figures were bolstered by the one-time sale of 75 million shares of Mitsubishi Motors, which improved the bottom line by $309 million. If this is taken into account, then Chrysler's management actually did a better job of managing the company in this category in 1990 compared to the year before. And that's why we weren't as harsh in our grading as you might otherwise expect. Not surprisingly, this small profit margin and the current cash crunch forced Chrysler to cut its dividend in half, which it just announced last month. This move should save the company about $130 million in cold cash a year.

Productivity: After making such solid gains in productivity in the last four years, Chrysler dropped off seriously in this area. And the weak US market doesn't explain all of the downfall. Strangely, despite the company's tremendous sales slowdown, and the closing of the Jefferson Avenue and St. Louis assembly plants, Chrysler's total automotive employment actually increased by nearly 4000 people in 1990. That's not much, but it sure isn't the kind of trendline one would expect to see – especially when GM was able to reduce its worldwide automotive employment by 13,000 people.

Inventory Turns: This is another area where Chrysler fell off, after having made impressive gains recently. Inventory turns fell 14.4% compared to last year, showing how difficult it is to balance production schedules when the market is in a steep and unpredictable slide. Even so, amongst the Big Three, Chrysler is still best-in-class, and that had a positive effect on our grading. AJ

Will A604 transmission problems and increasingly tough competition put a serious dent in Chrysler's Number One money maker?

PRODUCTIVITY COMPARISON

Who has the best assembly plants in the North American auto industry?

by JOHN McELROY

Last year, Harbour and Associates published The Harbour Report, *a competitive assessment of how the North American automotive industry performed during the 1980s. The following charts from that report (with selected plants updated for 1991) compare the productivity of the car and truck assembly plants operating in the United States and Canada.*

A productivity comparison of assembly plants shows that the Ford Motor Company and the Japanese transplants have—by far and away—the most efficient operations in North America.

When comparing the productivity for passenger cars, Ford is close on the heels of the transplants, trailing by only 2.7%. But Chrysler lags by a significant 28.7%, and GM is an astounding 62.3% less efficient.

On average the Japanese transplants in North America need only 3.27 workers per car per day, though this includes extra operations which are explained below. Ford needs only 3.36 workers per car per day in passenger car assembly, compared to 4.21 at Chrysler and 5.31 at GM.

The **most efficient passenger car assembly plant** in North America is the CAMI operation in Ingersol, Ontario in Canada. The plant is run by executives from Suzuki and builds the Geo Prizm/Suzuki Firefly and the Geo Tracker/Suzuki Sidekick.

The **most efficient Big Three car assembly plant** is Ford's Atlanta plant, which makes the Taurus and Sable. And Ford has several other plants that are very close to Atlanta's world class level of efficiency.

The **most efficient truck assembly plant** in North America is Ford's Kansas City plant which makes F-series pick-ups and the Tempo compact car.

The **most efficient transplant truck plant** is Nissan's Smyrna facility that makes compact pick-ups and Sentras.

It should be pointed out that these productivity rankings do not reflect the quality of the vehicles made at these plants. For example, according to J.D. Power's Initial Quality Survey, General Motor's Buick City plant, which ranks 21st on the productivity list, actually assembles the most defect-free car made in America, which is the Buick LeSabre. Also, GM's Saturn plant is not on this list because at press time it hadn't reached line speed, so productivity numbers were impossible to come by.

Some people will be surprised to see so many Ford plants rated ahead of the transplants. This is partly because the transplants perform extra operations, such as stamping and plastic molding, that are typically not found in Big Three assembly plants. However, new or re-tooled Big Three assembly plants, such as Ford's Wayne plant and GM's Fairfax plant and Saturn, increasingly incorporate these kinds of operations on-site.

The overall conclusion one can draw from these car and truck productivity comparisons is that the best plants in North America are very competitive with the best plants in Japan. They're world class. But the worst plants—unless they make significant improvements—may not survive the overcapacity crunch in North America. Some of them are likely to risk extinction by the end of the century.

How We Measured Productivity

One of the easiest ways to start an argument in the auto industry is to talk about productivity. Every expert has an opinion, and they all use different methods to measure it.

The only way to avoid an argument on productivity is to agree on what you're going to measure and *how* you're going to measure it. The problem is that two of the most common methods that are used, cars/employee/year and man-hours-of-assembly, have flaws.

The problem with the cars/employee/year formula is that it only works well when production is slowly increasing. Since it doesn't take overtime or downtime into account, it overstates changes in productivity when

volume fluctuates significantly.

The problem with the man-hours-of-assembly formula is that hours of overtime and absenteeism rates must be used in the calculations. As long as you can get those figures, you'll be able to calculate the productivity rate. Unfortunately, the automakers don't make this information public. And while it's possible to estimate these figures, guessing is a haphazard way to make accurate comparisons.

The best way to calculate productivity, without overstating any changes in production, and without having to guesstimate, is to use workers per unit of output, or as is shown in the accompanying charts, workers per car and workers per truck. This calculation takes the annual output at a plant and divides that by the number of workers who work there. The number of work days at the plant is then divided by the number of cars or trucks each worker made during the year. This calculation does not take absenteeism into account and it does not recognize overtime. Nonetheless, it represents a consistent and accurate system that is particularly effective for analyzing productivity over a lengthy period of time.

Continued on p.54

RANKING THE CAR ASSEMBLY PLANTS

Company	Plant	Product	Workers Per Car	% Over Base	Comments
1. CAMI	Ingersol	Metro/Tracker/Sidekick	2.40 A	Base	The Best in the West
2. Ford	Atlanta	Taurus/Sable	2.66	10.8%	Best Of Big Three
3. Ford	Chicago	Taurus/Sable	2.68	11.6%	Look Out Atlanta!
4. Ford	Kansas City	Tempo/FS P-Up	2.68	11.6%	Large Volume Helps
5. Ford	Oakville	Tempo/Topaz	2.82	17.5%	Good Show, Eh?
6. Honda	Alliston	Civic	2.88 A	20.0%	Uses Marysville Parts
7. Honda	E. Liberty	Civic	2.89 A	20.4%	Same As Above
8. Nissan	Smyrna	Sentra/P-Up	2.98 A	24.1%	Solid Showing
9. Diamond Star	Normal	Eclpise/Laser	3.00 A	25.0%	Successful JV
10. Chrysler	Sterling Heights	Sundance/Shadow	3.18	58.7%	Chrysler's Best
11. Ford	Dearborn	Mustang	3.24	35.0%	Old, Old Car
12. SIA	Lafayette	Legacy/P-Up	3.32 A	38.0%	Needs Volume
13. Toyota	Georgetown	Camry	3.54 A	47.5%	Not A UAW Plant
14. Mazda	Flat Rock	626/MX-6/Probe	3.56 A	48.3%	A UAW Plant
15. Honda	Marysville	Civic/Accord	3.61 A,C	50.4%	Extra Operations
16. Ford	Wayne	Escort	3.61 A	50.4%	Start-Up Phase
17. NUMMI	Fremont	Prizm/Corolla	3.73 A	55.4%	A Toyota Operation
18. Chrysler	Belvidere	Dynasty/N.Y./Imp.	3.74	81.2%	Mid-Size Luxury
19. Ford	Lorain	T-Bird/Cougar	3.76	56.6%	Should Be Better
20. Ford	St. Thomas	Crown Vic/Marquis	3.93	63.7%	New Car Will Help
21. General Motors	Linden	Corsica/Beretta	3.94	64.1%	GM's Best
22. Chrysler	Newark	Acclaim/Spirit	3.95	81.6%	Go Catch Sterling
23. General Motors	Buick City	LeSabre/88	4.04	68.3%	High Quality Plant
24. Toyota	Cambridge	Corolla	4.05 A	68.7%	Last Place Transplant
25. General Motors	Wilmington	Corsica/Beretta	4.31	79.5%	Way Behind Linden
26. Chrysler	St. Louis	LeBaron/Daytona	4.36	80.4%	Soon To Close
27. General Motors	Lansing	'N' Cars	4.39	82.5%	Handles Exports, Too
28. Ford	Wixom	Lincoln	4.86	102.5%	Three Platforms
29. General Motors	Oshawa	'W' Cars	4.87	102.9%	Not So New Mid-size
30. General Motors	Lordstown	'J' Car	4.96	106.6%	Old Product
31. General Motors	Oklahoma City	'A' Cars	5.19	116.2%	Old Mid-Size
32. General Motors	Fairfax	Grand Prix	5.25	118.7%	GM's Newest Plant
33. General Motors	Arlington	'B' Cars	5.28	120.0%	Old Brougham
34. General Motors	Wentzville	Park Avenue	5.42	125.8%	Big Cars/Big Manning
35. General Motors	Doraville	Cutlass	5.50	129.1%	One Car Plant
36. General Motors	St. Therese	Ciera	5.51	129.5%	Old Mid-Size
37. General Motors	Van Nuys	Camaro	5.62	134.1%	High Freight Too
38. General Motors	Orion	DeVille, 98	5.94	147.5%	Same As Wentzville
39. General Motors	Ypsilanti	'B' Cars	6.91	187.9%	Should Equal St. Thomas
40. General Motors	Hamtramck	'E'/'K' Cars	7.85	227.0%	Only One Shift

Excludes: Reatta/Corvette
(A) With Body Stamping, Stamping Assembly, or Major Injection Molded Plastics; Without Seats
(B) With Light Duty Trucks
(C) Includes Supplier Quality, Product Engineering Staffs
(D) With Medium Duty Trucks

Continued from p. 53

RANKING THE TRUCK ASSEMBLY PLANTS

Company	Plant	Product	Workers Per Car	% Over Base	Comments
1. Ford	Kansas City	F-Series/Tempo	2.68	Base	Best In The West
2. Ford	Norfolk	F-Series	2.72	1.4%	A Close Second
3. Ford	Louisville	Ranger/Explorer	2.81	5.2%	New Product Added
4. Nissan	Smyrna	P-Up/Sentra	2.98 A	11.1%	Best Transplant
5. Ford	Ontario Truck	F-Series	3.02	12.6%	Best In Canada
6. Ford	Twin Cities	Ranger	3.05	13.8%	Compact Truck
7. Ford	Michigan Truck	F-Series	3.15	17.5%	Full-Size Truck
8. General Motors	Fort Wayne	C/K Truck	3.23	20.5%	GM's Best
9. SIA	Lafayette	P-Up/Legacy	3.32 A	23.8%	Needs Volume
10. General Motors	Moraine	S10	3.35	25.0%	Compact Truck
11. Ford	St. Louis	Aerostar	3.36 B	25.3%	Best Minivan
12. General Motors	Shrevesport	S10, Blazer, S15	3.39	26.4%	Look at Louisville
13. General Motors	Pontiac East	C/K Truck	3.54	32.0%	Newest Truck Plant
14. General Motors	Oshawa	C/K Truck	4.04	50.7%	Next Best In Canada
15. Ford	Lorain	Big Van	4.10 A	52.9%	Best Large Van
16. Chrysler	Windsor	Caravan/Voyager	4.39	63.8%	Best From Chrysler
17. Chrysler	Warren	Dakota/P-Up	4.63	72.7%	Compact Truck
18. General Motors	Baltimore	Astro/Safari	4.92	83.5%	Way Behind Ford
19. General Motors	Janesville	Med. Truck	4.94	84.3%	No More J-Car
20. General Motors	Pontiac West	S10, Blazer, S15	5.00	86.5%	To Be Closed
21. General Motors	Lordstown	Big Van	5.17	92.9%	To Be Closed
22. Chrysler	Pillette	Big Van	5.17	92.9%	Not Any Better
23. Chrysler	Missouri	Caravan/Voyager	5.32	98.5%	Extended Van
24. General Motors	Flint	Suburban/Blazer	6.17	130.0%	To Be Closed
25. Chrysler	Toledo	Jeep	6.87	156.3%	Includes Stamping
26. General Motors	Scarborough	Big Van	7.15	178.0%	Closing Soon?

(A) With Cars (B) With Light Duty Trucks

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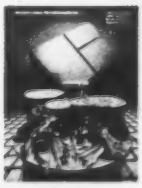

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THE WORLD'S FASTEST GROWING MARKET

The Pacific Rim nations of Southeast Asia are consistently scoring double-digit growth. Japan sets its sights on Thailand.

by JOSEPH M. CALLAHAN

While Western automakers have focused on new business opportunities in Eastern Europe, Japanese automakers are aiming to make Southeast Asia the world's low-cost location for assembling vehicles and making parts.

The Honda Motor Co. expects Thailand to be its third largest production base next to Japan and the US, according to Dr. Kosol Surakomol, managing director of Bangchan General Assembly Co., which assembles CKD (complete knock-down) kits from Honda, Opel, Isuzu and others. And he says Honda is also considering Thailand as a major base of exports throughout Southeast Asia—a stupendous projection for a country that assembled just 82,000 vehicles in 1985.

Toyota, Nissan, Mitsubishi, Mazda and Isuzu see Southeast Asia as a key link in their global strategies for the 1990s, writes Michael Dunne in his recently published study, *The State of the Auto Industry in Thailand*.

Besides its low costs, the Pacific Rim has another major attraction. The region is home to a third of a billion people, and that's not counting China and Japan (see chart).

Thailand will become one of the world's largest automotive manufacturing centers by 1995, industry analysts predict, exporting components, systems and finished vehicles in significant volume to markets in Europe, Asia and North America. The country already has one of the hottest economies in the world, racking up increases in GNP of 10.9% in 1988, 10.5% in 1989 and 9.9% in 1990.

Already the Japanese and some European firms have announced plans to almost triple their automotive assembly capacity by 1995, boosting it from 283,500 units now to 746,000 units in four years. The expanding firms include Bangchan General Assembly, Isuzu Motors (of Thailand), MMC Sitipol (Mitsubishi), Siam Motors (Nissan), Sukosol and Mazda Motor, Tai Hino, Thai-Swedish Assembly (Volvo, Renault), Thornburi Auto Assembly (Daimler-Benz), Toyota Motor Thailand and Yontrakit Motor (BMW, Peugeot and Citroën).

Conspicuously absent from the list of foreign automakers expanding into the region are the Americans. Except for a limited number of Holden and Opel cars, GM and Ford have pulled out of the operations they had in the region in the 1970s. Both companies now have teams again studying the resumption of vehicle assembly in Thailand.

But their start-up will be difficult. Thailand has very stringent local-content rules: 62% for pick-up trucks (Thailand's national vehicle), 54% for cars and 45% for heavy-duty trucks.

Moreover, just as the Japanese automakers have managed to seal off their home market to foreign suppliers, they appear to be doing the same in Southeast Asia. The Japanese, who now sell 95% of the vehicles in Thailand, have them all arranged in 'clubs,' in which they do business with just one Japanese firm and nobody else. AI

PACIFIC RIM MOTOR VEHICLE PRODUCTION*

Country	Population[1]	Car Production	Commercial Vehicles Production	Total Vehicle Production	% of S.E. Asian Production
S. Korea	43,100,000	871,888	257,572	1,129,970	7.3
Taiwan	20,000,000	256,437	77,404	333,841	2.1
Thailand	55,600,000	58,761	154,787	213,548	1.4
Indonesia	184,600,000	31,906	146,886	178,792	1.1
Malaysia	17,400,000	79,962	43,278	123,240	0.8
Hong Kong	5,700,000	31,947	18,306	50,253	0.3
Singapore	2,700,000	32,692	6,241	39,933	0.2
TOTALS	329,000,000	1,363,593	704,474	1,769,577	99.9

** 1989 Figures from MVMTA, MVMA (US), The Economist Intelligence Unit (Great Britain) and others.*
[1] United Nations 1989 population estimates.

INDUSTRY OUTLOOK

by JOHN McELROY

When it comes to predicting what will happen in the North American auto industry, the Big Three and the transplants, the captive suppliers and the independents, all have different opinions.

Automakers and suppliers operating in North America know they have their work cut out for them. But they don't exactly see eye-to-eye on which problems loom largest. Nor do they agree on the best ways to tackle these problems. And the divergence of opinion is quite significant between the Big Three and the Japanese transplants, as well as between captive and independent suppliers.

These differences were recently brought to light by a major study of the US automotive market, *The New Automotive Frontier: Effective Implementation*. The study is based on answers to questionnaires from nearly 1000 executives in the auto industry, including 170 participants from the Big Three and Japanese transplants, 259 participants from captive suppliers, and 544 participants from independent suppliers including Japanese-owned companies with facilities in the United States. The study was conducted by Arthur Andersen and Company under the direction of Peter C. Van Hull and Shari T. Guilfoile.

The report gets its name from the fact that many people in the auto industry believe their companies have good plans and strategies to improve their competitiveness, but they don't think their companies are effective at implementing them.

The Arthur Andersen firm is well known for the six Delphi studies of the auto industry it has conducted since 1978. But for *The New Automotive Frontier*, the company dropped the Delphi methodology. Instead of asking participants where they thought the industry as a whole is headed, they asked them to comment specifically about their own companies.

Source: Arthur Andersen & Co. Figures 1 & 2

What do you believe are the primary product and process technology drivers for your products between now and 1995?

Product Technology Drivers

	Vehicle Manufacturers	Suppliers
Variable cost reduction	22%	28%
Investment cost reduction	11	7
Improve product features and functionality	**25**	**39**
Improve product performance	19	26
Quality and durability improvement	**39**	**36**
Satisfy government regulations	**25**	11
Weight and mass reduction	12	19
Speed to market	17	9
Market flexibility and responsiveness	13	10
Ease of manufacturing and assembly	18	15

Process Technology Drivers

	Vehicle Manufacturers	Suppliers
Variable cost reduction	38%	**58%**
Investment cost reduction	32	31
Improve product features and functionality	1	5
Improve product performance	6	6
Quality and durability improvement	**40**	**36**
Satisfy government regulations	5	4
Weight and mass reduction	-	4
Speed to market	10	6
Market flexibility and responsiveness	26	15
Ease of manufacturing and assembly	**41**	35

And whereas the Delphi method would have aggregated these answers to provide an "average" or overall viewpoint, the new method allows the participants' responses to be broken out by where they're from and what they do.

For example, any of the questions

can be grouped by answers from US vehicle manufacturers, Japanese vehicle manufacturers, captive suppliers, US independent suppliers and Japanese independent suppliers. Even more, each of these categories can be further broken down by the area of expertise the respondants represent including: body exterior; body interior; powertrain; chassis, steering, suspension, and brakes; electrical and electronics.

By being able to break out the answers to this level of detail, the study allows a company to accurately establish competitive benchmarks as to how it views the industry vis-à-vis its competitors. Arthur Andersen is making the full benchmark study available for $3000. A more concise overview is offered for $300 and is summarised below.

Major Findings

The data contained in the *The New Automotive Frontier* is too extensive to thoroughly cover here. Nonetheless, there are four significant areas that help set the overall tone for the report. The first deals with the most important market forces facing the auto industry in the next five years. The next two areas deal with those items most critical to driving improvements in product and process technology. Finally, the report also delves into the roadblocks that are preventing the effective introduction of new technology. Each of these areas provides plenty of data to stimulate interest and analysis.

Not surprisingly, automakers and suppliers alike feel that improvements in quality and cost reduction will be the most important issue facing them in the next five years (see Figure 3). But while automakers are sharply focused on reducing their product life cycles and leadtime, suppliers have other more pressing items on their agenda.

Suppliers indicate they are more concerned with globalization, recognizing that the biggest growth in the industry will likely take place outside of the North American market. GM and Ford and the Japanese automakers already have extensive international operations, and US-based

Most important market force issues facing your organization during the next five years.

	Vehicle Manufacturers	Suppliers
Niche marketing and product proliferation	12%	17%
Industry globalization	25	**38**
Shorter product life cycles and development leadtimes	**52**	**34**
Continual technology innovation	15	33
Vehicle systems trends	6	16
Increasing consumer/customer expectations	30	31
Slower market growth	19	19
Larger number of competitors	25	14
Excess production capacity	**38**	19
Pressure for continuous quality and cost improvement	**78**	**76**

Figure 3

Source: Arthur Andersen & Co.

suppliers are now recognizing they too must have overseas facilities if they are to retain their client base.

Additionally, these suppliers place a greater premium on continuous technological innovation than do the automakers. This suggests that suppliers see proprietary technology as a key to capturing new business and as a way to command higher profit margins. Interestingly, while the vehicle manufacturers are worried about overcapacity in the market, suppliers seem to feel that they've got their capacity pretty much in line with demand.

When it comes to ranking which issues are most important in improving product technology, the automakers bore in on quality and and durability (see Figure 1). Suppliers are also concerned with this, but they rank improvements in product features and functionality as their number one product concern. This may mean that suppliers are now more focused on designing products that meet their clients' and customers' needs and expectations. And dovetailing with this focus on better design is the suppliers' concern to reduce variable costs, an issue they rate higher than satisfying government regulations.

Recognizing that it is ever more difficult to separate design from manufacturing, reducing variable costs is also the suppliers' top concern in terms of improving process technology (see Figure 2). The automakers, on the other hand, rate ease of manufacturing and assembly as their top process priority. This seems to tie in with the industry's recognition that it must be ready and able to meet changes in market demand, especially as this relates to low-volume and niche vehicles.

Interestingly, both automakers and suppliers blame their respective managements for the ineffective or inconsistent introduction of new technology (see Figure 4). Both rate short-term management focus as the most significant problem in this area, while the automakers are equally critical of unclear management direction and priorities. Suppliers also say that their customers, the automakers, don't clearly communicate what they need or want, which ties in with the unclear management direction that automakers say they suffer from. It's also clear that as suppliers take on more design and engineering responsibilities, they're concerned that they don't have the internal competence or capabilities to get the job done—an acute problem since suppliers believe that development leadtimes will be more compressed (see Figure 5).

Reasons for Ineffectiveness and/or Inconsistency

	Vehicle Manufacturers	Suppliers
Poor customer/supplier relationships (lack of communication, early sourcing, etc.)	29%	17%
Exploding technology has dissipated resources	11	15
Unclear management direction and priorities	**53**	**34**
Lack of understanding of consumer/customer needs and wants	13	27
Inadequate financial resources	15	16
Supply community lacks expertise	2	3
Lack of internal core competencies/ capabilities	25	27
Short-term management focus	**53**	**47**
Aversion to risk	28	14

Figure 4 Source: Arthur Andersen & Co.

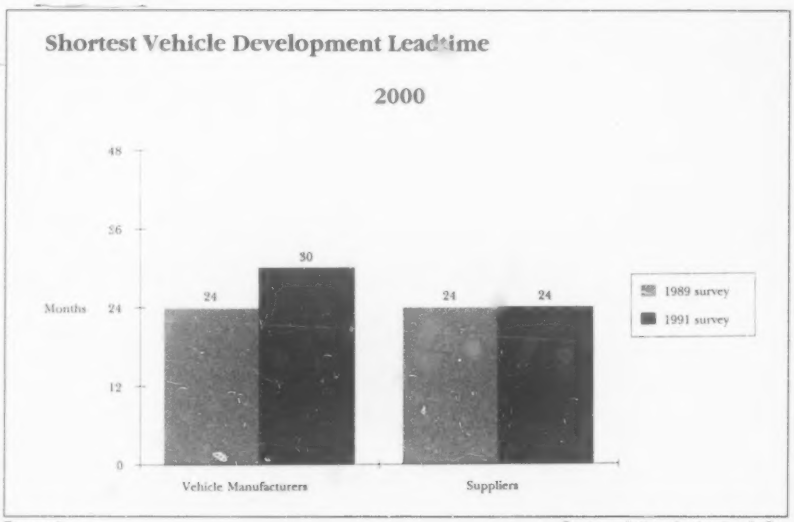

Figure 5 Source: Arthur Andersen & Co.

How To Order

Additional benchmarking topics covered in *The New Automotive Frontier: Effective Implementation* include product life cycles, development leadtime reduction, investment targets, potential unit cost reductions, target costing, translation of product concepts into specifications, quality gaps between US and Japanese owned facilities, captive vs. independent supplier sourcing, the status of customer/supplier relationships and much more.

For a brochure, or to place an order, contact: Donna Borrelli, *Automotive Industries*, One Chilton Way, Radnor, PA 19089. Tel: (215) 964-4245. Fax: (215) 964-4981. AI

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CHILTON'S
AUTOMOTIVE INDUSTRIES
MAY 1991
THE PEOPLE — THE PRODUCT — THE PROCESS

A postwar oil glut

CAFE: 40 mpg

Why the industry can't meet it.

What the industry can do.

FOR CARMAKERS, THE BAD NEWS IN THE AIR

The auto industry, with a big push from its friends in the Bush Administration, has managed to sidetrack legislation that would have required a massive increase in the fuel efficiency of cars. But the victory offers Detroit nothing more than a temporary reprieve.

The auto makers' woes are mounting fast. Soaring oil prices and a sagging economy threaten to torpedo already shaky car sales. Congress is about to enact a revised Clean Air [Act] requiring tough new emissions standards and large-scale production of cars that can burn alternative fuels. And the [energy] efficiency bill, which has strong backing in both Houses, will [be passed] this year.

CAFE standards won't help

achieve an [average] ... for their car fleets. ... Lately, ... proposed increasing the CAFE ... continues to be debated. Below we present sides of this debate. Arguing in favor of standards is Clarence Ditlow, head Center for Auto Safety. The Secretary Department of Transportation, Samuel K ... cites problems with increasing the CA ... addition, we present evidence that gests that current CAFE standards have the cars we drive less safely. —Ed.

ELECTRIC CARS IN CALIFORNIA?

It hasn't been a particularly good year for auto companies. Sales are off, and Congress is considering new standards for fuel economy. Now, California is about to push through the most stringent auto-emissions regulations in the country. The rules are so tough [that] ... auto companies ... improved fuel ...

BRYAN: PUSHING NEW FUEL-ECONOMY LIMITS

...se in CAFE

...kinner

... by Senator Bryan and oth... substantially increase the ...er. With Congress rush... ...r cars and light trucks ... enough to kill the measure ... lobbyists are already ...ates. The bill would

More CAFE.

By Clarence M. Dit...

The motor vehicle ... mandated by Congress ... nificant energy conser... country. The question ... should be increased b... ...er for Auto Safety ha...

Deba... on fu... econ... flar...

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WAS...

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Cheap oil for years to come.

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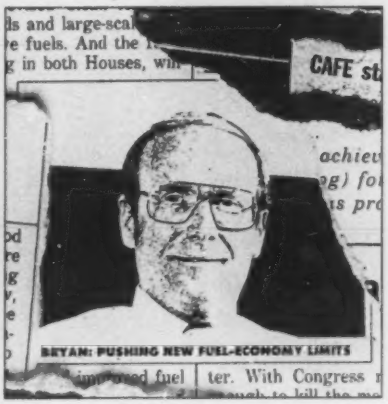

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Volume 171, No. 5 May 1991

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40-MPG CAFE

Everyone agrees the US must reduce its dependence on oil. Now the issue will be decided in Congress. Once again the auto industry has missed an opportunity.

by LINDSAY BROOKE, GERRY KOBE, JOHN McELROY and CHRISTOPHER A. SAWYER

Senator Richard Bryan has become a household name in the auto industry. The Nevada Democrat adamantly believes the auto industry can improve the fuel efficiency of its vehicles. And he's right. The industry believes it can improve fuel efficiency, too. But an argument – a big argument – arises when you ask by *how much* fuel economy can be improved.

Senator Bryan says it's possible to achieve a 20% improvement in Corporate Average Fuel Economy (CAFE) by 1996, and a 40% improvement by 2001. Automakers respond by saying such a law is either impossible to achieve, or not worth implementing. Honda, for example, claims it could make a 5% improvement. General Motors points out it already sells Geo Metros that achieve 50 mpg, but customers are not exactly trading in their Buicks to buy them.

"Raising vehicle fuel efficiency standards is a very indirect and inefficient flawed way of trying to reduce oil imports through fuel conservation," said Thomas Hanna, president and CEO of the Motor Vehicle Manufacturers Association, in a March testimony before the House Subcommittee on Energy and Power.

At this juncture who's right is a moot point. One way or another the issue is going to be settled by the political process, because even if the Bryan bill is shot down in flames, there are six other CAFE bills waiting in the wings. Reacting to the Persian Gulf war and the Valdez oil spill, Congressional Democrats perceive there is a national mandate to reduce the country's dependence on oil – especially foreign oil – and want to use legislative muscle to make it happen. Conversely, Republicans generally prefer to see the marketplace regulate any kind of improvement.

So the fight has now boiled down to who is the most persuasive. And right off the bat the auto industry has two strikes against it.

"The auto industry has a history of denying anything is possible, then proving itself wrong by going out and doing it," says Steve Plotkin, a senior associate at the Office of Technology Assessment (OTA).

Moreover, Senator Bryan has amassed a persuasive list of facts. His call for massive CAFE improvements is based on technical reports and testimony to Congress from the OTA, EPA, DOE and national laboratories at Oak Ridge and Berkeley. These reports indicate that a 40 mpg CAFE is achievable by 2000.

True, say some in the auto industry. But even if it is 'achievable' that doesn't mean it's 'affordable.' And even the most ardent hold-their-feet-to-the-fire regulators concede that big improvements in fuel economy won't come cheaply. That's a deeply troubling fact to the auto industry.

In 1990, the typical new car cost $16,500 including nearly $2500 worth of government-mandated fuel economy, emission and safety equipment. Inflation alone will likely push that sticker price to $25,000 in 10 years, and automakers are concerned that family incomes won't keep pace. What good is a fuel-efficient family car that families can't afford, ask auto industry executives? MVMA president Hanna adds that a resulting drop in sales could cause the loss of over 150,000 US automotive industry jobs.

But others say that consumers will recoup that added expense when the fuel savings are spread over four or five years. Besides, say those involved in the political process, Congress knows it is forcing the auto industry to do the impossible, just as the auto industry knows it can do more than it admits to. That's how the game is played.

"When you're in the bargaining process it pays to hold to your position until the last possible moment," says Steve Plotkin at the OTA. "There's no incentive for anyone in the industry to say it can be done; otherwise this feeds the drive for big fuel economy improvements."

He adds that the authors of the technical reports on which the Bryan bill is based acknowledge that a 20% or 40% CAFE improvement would be difficult to achieve without a radical and total redesign of the fleet. Since the 1996 models are already on the drawing board, and many models are already planned out through 1998, it would be virtually impossible for automakers to recoup their investment on these cars if faced with a stringent CAFE bill.

A more realistic CAFE goal by 1996, says Plotkin, is a 30 mpg CAFE. "The national CAFE is already at about 28 mpg and it'll get to 29 mpg on its own," he notes, "so we're saying you can squeeze 1 mpg more by 1996." A 38 mpg CAFE would be feasible by 2001, he says, provided automakers are given generous CAFE credits for flex-fuel cars – cars that can run on a combination of gasoline and methanol or other alternate fuels. Currently such credits are capped to 1 mpg, but the Bush Administration is asking for them to be uncapped.

"A lot of the people who have heard us [the OTA] know we're talking about numbers that are lower [than those in the Bryan bill]. I think we are making an impression on Congress, and I suspect 20% and 40% will not be the final numbers," says Plotkin.

So what will the final number be? That depends on Congress.

VEHICLE FUEL ECONOMY PROPOSALS IN CONGRESS

Bill:						
S.279 [1]	S.341 [2]	S.741	HR.446	HR.550	HR.612	HR.1543 [3]
Main Sponsor:						
Sen. Richard Bryan (D-NV)	Sen. J. Bennett Johnston (D-LA)	Sen. Tim Wirth (D-CO)	Rep. Barbara Boxer (D-CA)	Rep. Leon Panetta (D-CA)	Rep. Dan Glickman (D-KS)	Rep. Norman Lent (R-NY)
Proposed Improvement Over 1988 CAFE, by MY 1996:						
Cars:						
20%	Max. Feas. Level	20%	20%	20%	25%	Max. Feas. Level
27.5 mpg City/40 Hwy	Set By DOT	27.5/40	27.5/45	27.5/40	27.5/–	Set By DOT
Light Trucks:						
20%	Max. Feas. Level	20%	20%	20%	25%	Max. Feas. Level
20 mpg City/30 Hwy	Set By DOT	20/30	20/35	20/30	20/–	Set By DOT
Proposed Improvement Over 1988 CAFE, by MY 2001:						
Cars:						
40%	Max. Feas. Level	40%	60%	40%	50%	Max. Feas. Level
33 mpg City/45 Hwy	Set By DOT	33/45	27.5/50	27.5/45	35/–	Set By DOT
Light Trucks:						
40%	Max. Feas. Level	40%	60%	40%	50%	Max. Feas. Level
24 mpg City/35 Hwy	Set By DOT	24/35	20/40	20/35	25/–	Set By DOT

[1]DOT secretary may increase or decrease standard based on 'maximum feasibility' test. Reduction may not exceed 5%, 1996-2000; 10%, 2001.
**Non-compliance fine is doubled if manufacturer falls short of standard for three consecutive years, by more than 0.05 mpg, beginning MY 1996.*
[2]Mileage credits earned by exceeding standards may be traded among vehicle manufacturers, for MY 1996.
**Small cars with driver's side airbags earn 5% fuel economy value; driver's/passenger's side airbags earn 10%.*
**DOE to provide aid to states to scrap pre-1980 vehicles.*
**Non-compliance fee replaces CAFE fine; raised to $20 per 0.1 mpg under MY 1996 standard. 1993 raised to $10.*
[3]Proposes DOT rule-making based on auto industry lead times and safety considerations. Proposes two-stage CAFE inprovements, the first to begin in the fourth MY after passage.

ON THE DOCKET

Even if the Bryan bill has been voted down by the time you read this, similar legislation is on the docket. At the time *Automotive Industries* went to press, there were seven fuel economy bills pending in the US Congress – three in the Senate and four in the House of Representatives, as the above chart shows.

'VAFE': ANOTHER ALTERNATIVE

Instead of CAFE, why not tailor fuel economy standards to the average interior volume of automakers' fleets – VAFE, or Volume Average Fuel Economy?

"You want to make a car as light as possible while maintaining safety, but you want an incentive for that weight reduction," the OTA's Steve Plotkin says. "So when you talk about size, you're looking for something which approximates utility. And interior volume, if it's measured properly, is not a bad measure of that."

Plotkin explains that VAFE could take two forms: It could be fuel economy standards tailored to EPA interior volume classes, or it could be based on a curve of fuel economy and interior volume.

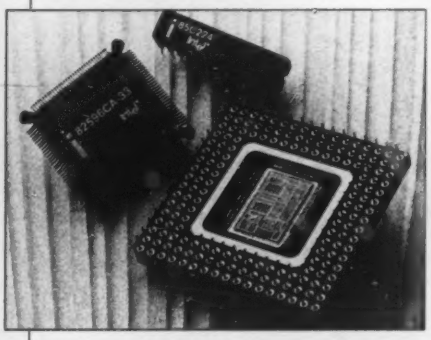
The VAFE proposal has yet to be incorporated into any legislation, and it's got a few political strikes against it already. "First, it's not as easy to explain as a uniform percentage increase like Bryan's, and there's no push in it for small cars," admits Plotkin. "Some senators really believe that one of the things we ought to be doing is getting people into small cars. VAFE has no incentive at all like that."

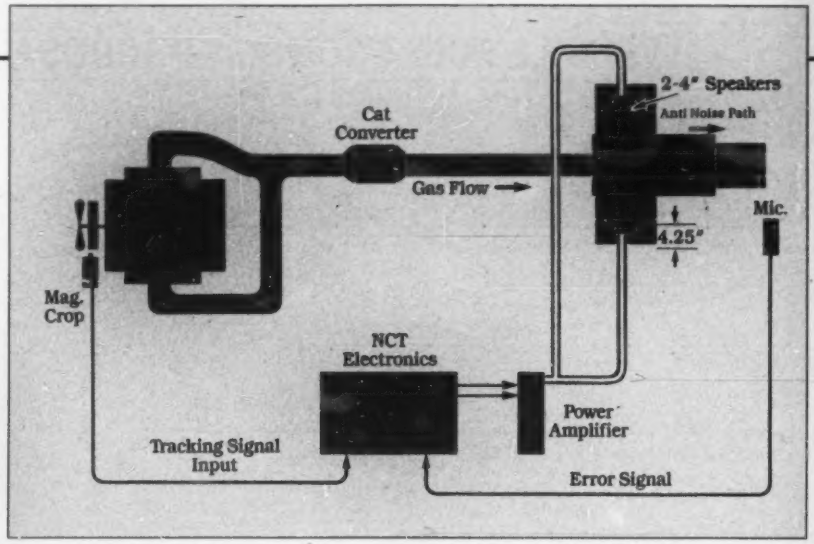
So the only format that will guarantee a minimum fleet fuel economy average is the current CAFE – "and that's the one nobody wants," he says.

Nevada's Richard Bryan (top) weighs the cost of 40-mpg CAFE with the cost of maintaining a military presence in the Middle East. Louisiana's J. Bennett Johnston's (bottom) bill is calling for a non-compliance fee that's four times stiffer than the current penalty for automakers.

40-MPG CAFE

32-bit micro's, like Intel's i486, will allow real-time powertrain control.





Electronic mufflers could improve fuel economy by 5%. Illustration: Walker/NCT

ON THE SHELF

A major challenge in meeting tighter CAFE standards is finding production-ready, on-the-shelf technology that offers a good return on investment. Since all 1995 models are already being developed, any legislation requiring massive fuel economy improvements by model year 1996 means that such technology must be available today.

We spoke with vehicle, powertrain and electronics engineers to determine what could be fitted to current projects. Certainly, there is a lot of new technology that will be coming in the next five years, and even more in the next decade. But these engineers claim there's nothing magic on the shelf which, by itself, will yield an instant 4 or 5 mpg. And they point out that any gains will be incremental, noting that you can't add up the incremental gains on a percentage basis to come up with the 20% or 40% required in legislation such as Sen. Bryan's.

Powertrain

So where will the auto industry concentrate its efforts? As might be expected, much of the push for more miles per gallon has focused on engine technology. According to Don Miles, a chief engineer at GM Powertrain, bumped-up compression ratios, to the 10:1 level and beyond, when used with freer-flowing ports, can improve combustion and fuel economy – if combined with higher octane fuel and remapped engine controllers.

And while many CAFE think-tankers sing the praises of multivalve cylinder heads, Miles points out they don't offer a 'free lunch.' While the multivalve engines offer improved combustion, they are compromised in other areas. Twice as many valves, guides, lifters and bearing surfaces can require up to 60% more oil flow for lubrication and cooling, which can multiply an engine's parasitic losses.

Additionally, with dohc there's often more engine weight – over 70 lbs. more when comparing some two-valve and four-valve V6s. More powertrain weight requires beefier cradles and heavier suspension pieces. To help cut weight, thinner-wall engine castings and more aluminum and plastics are coming.

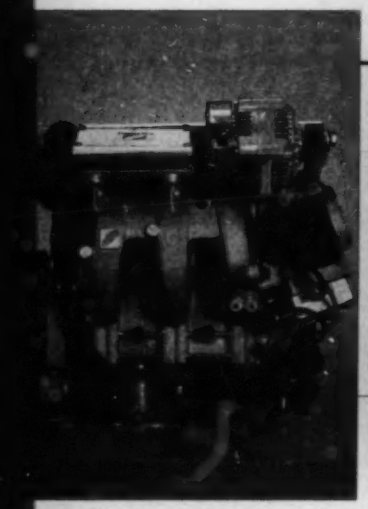
As an alternative to gasoline-powered engines, some powertrain engineers predict a return of the small-to-medium displacement turbodiesel. These engines are currently popular in Europe and would probably have to be purchased by the Big Three.

Of new piston engines on the near horizon, the most promising in terms of fuel efficiency is the two-stroke. Australia's Orbital Engine Co. is leading the pack here, with GM, Ford and Fiat as major automotive licensees. Orbital's 1.2 L three-cylinder, direct-injection, 90-hp two-stroke is half the physical size and weight of a typical 1.6 L sohc four-stroke four-cylinder. It gives about 12% better actual engine fuel economy than a 1.4 L sohc four installed in the same test car. And it has the potential to offer up to 30% better overall fuel efficiency, if installed in a car that's designed for it. Orbital officials reckon the engine's first US automotive use by their licensees will be bolted into an existing platform.

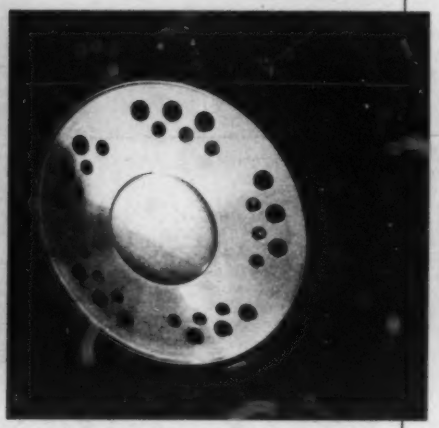
Improvements in transmissions will also play an important role. Higher gear ratios, taller final drive ratios, six- and seven-speed manual gearboxes and five- and six-speed automatics are all being considered. But they will require engines with fatter torque curves and lighter weight vehicles to maintain decent launch and roll-on acceleration. And adding cogs to existing gearsets means larger and heavier transmission cases – again, there's no free lunch. Other near-term fuel-saving technology includes de-clutching mechanisms and continuously-variable transmissions. CVTs are still torque-limited, however, and face durability questions when mated with engines larger than about 1.3 L.

Electronics

Of course, improvements in the powertrain aren't limited to hardware. Programming changes with on-board electronics could be accomplished fairly quickly, say experts in the electronics industry. By sacrificing performance, for example, engines could be electronically tuned to squeeze out the last drop of fuel efficiency. Some



Orbital's new 90 hp, three-cylinder, 1.2 L two-stroke (above left) will enter production soon. GM's highly-refined 3.3 L and 3.8 L V6s (above right) will add thin-wall iron block/head castings for less mass, roller rocker arms for less friction.



Tires designed to run at 50-65 psi, such as those fitted to GM's Impact electric car, drastically improve roll resistance.

experts also suggest that an 'electronic governor' limiting acceleration could be easily programmed into the engine microprocessor. Since it's merely a new algorithm, there would be no additional hardware cost.

More powerful microprocessors could also enhance fuel economy. Currently the most powerful micros are 16-bit machines. But GM will have a 32-bit machine in certain 1993 models and Ford will follow in 1997.

These powerful micros allow engineers to 'computer model' the combustion process. This refers to monitoring and controlling engine parameters such as valve and spark timing on a real-time basis. And by connecting engine controllers to electronic transmissions, they'll be able to select optimum shift points for better fuel economy.

With additional computing power, cruise controls could hold a car at its most fuel-efficient speed based on the load being carried in the car. But it would also take about $50 worth of sensors, such as a load level sensor, engine load sensor, to accomplish this.

If given more time, experts in the electronics industry say they have a few more tricks up their sleeves to boost fuel economy. Of special interest is the 'electronic muffler,' which uses DSP (digital signalling processing) chips to create sound waves that are equal and opposite to the sound waves coming out the exhaust pipe. This allows baffles to be removed from the muffler, reducing back pressure and weight.

According to muffler supplier Walker Manufacturing, this reduction in back pressure improves city fuel economy by 5% on a V8 powered car. However, noise cancellation systems could cost as much as $500.

Other electronic technology includes multiplexing that could improve diagnostic capabilities, but would add about $400 to the cost of a car. And fiber optics have the potential to replace long runs of wire. "It's estimated that in a typical car approximately one mile of wiring can be eliminated," says George English, director of lighting systems development for GTE Electrical Products.

Lightweight Materials

Virtually every automaker has looked at making cars using more exotic lightweight materials – at least more exotic than steel or plastic. But again, this approach won't be available in the short term. Ford has probably taken the boldest step with its Contour Project (see *AI* March '91, p. 24). According to Ford, Contour's aluminum spaceframe design would shave several hundred pounds off the weight of an all-steel body-in-white, while being very cost effective because it is extruded and bonded. However, the bonding process has yet to be proven for mass production.

Alternatives to aluminum include graphite or Kevlar/epoxy, which have been studied most extensively at GM. Kevlar/epoxy yields a spaceframe that gives repeatable and satisfactory crash results while using cost-effective materials. Weight savings of 150 lbs. could be realized over steel. The problem with K/E is that use of filament winding techniques or resin transfer molding is far too slow for mass production. Graphite has high strength and low weight but at an unacceptable cost, and is unpredictable in terms of repeatable crash results.

Components

Automakers are also looking at bolt-on componentry that could enhance fuel economy. For example, continuous tire 'tuning' – optimizing aspect ratios, adding new polymer technologies and designing for higher pressures – is sure to yield more miles per gallon along with better performance. A good example of this technology is the high-pressure Goodyear tire – designed for 50-65-psi – that's fitted to GM's Impact electric car prototype.

Bill Egan, Goodyear's chief engineer for advanced OE equipment technology, says tradeoffs of higher pressures include increased ride harshness and tread wear. "We've got to be able to keep a good 'footprint' geometry; that's a key to good tire performance," he notes. "We're working on that now."

Even a vehicle's cooling system offers the potential to reduce fuel consumption. Siemens is presently testing

40-MPG CAFE

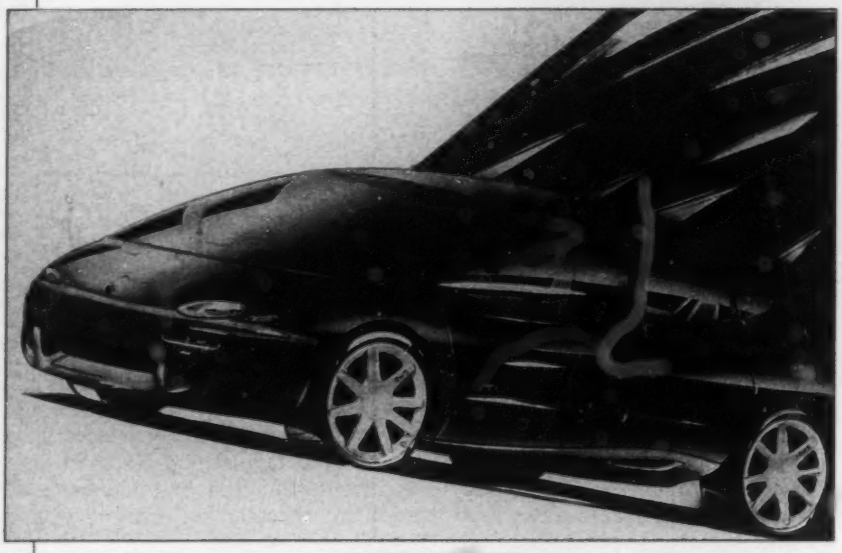
a ducted cooling system on a Mercury Sable that is designed to decrease underhood temperatures and lessen hot fuel handling problems. By lowering lower underhood temperatures, the fuel supply going to the engine can be made cooler. Colder fuel means a denser charge, more efficiency, and the chance to run the engine closer to the edge on performance.

In addition, with such a cooling system, air intakes can be optimized for greater aerodynamic efficiency. And Ford hopes that by ducting air from the cooling system into the front wheelwells it can 'trick' the airflow into 'seeing' a smaller frontal area by breaking the vortexes created by the wheels.

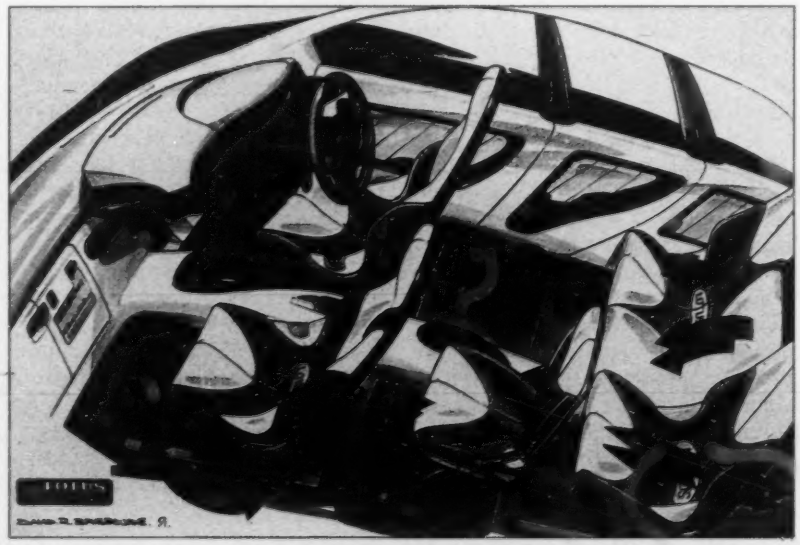
Other aerodynamic tricks could include an adjustable ride height – raking the nose down and raising the tail – to reduce aerodynamic drag by 3% to 5%. But it cannot be used to its full advantage due to government regulations for uniform bumper height. However, United Technologies Automotive has unveiled research which shows that 'vortex generators' offer a 30% Cd reduction in bluff body (square box) wind tunnel tests.

The vortex generators are simply sinusoidal waves – which look like corrugated curves – molded into the trailing edge of a decklid or spoiler. They cause the air coming off the rear of a car to spiral, mixing high pressure into low pressure areas to reduce turbulence. Moreover, they could be used in catalytic converters and mufflers to improve flow and reduce noise, or even integrated into a radiator to improve airflow there.

The list goes on and on. But as noted, none of this technology is expected to yield the massive fuel economy improvements Congress expects – at least not while maintaining today's levels of safety or performance. But if given more time, outside of today's cycle plans, the auto industry has some fairly clever ideas on the drawing board.



From Lotus: 60 mpg with 0-100 km/h in 6 seconds from a 1.2 L engine. Illustration: David R. Brisbourne, Lotus Design



Flexible interior gives mobile office, cargo and seven-passenger capability. Illustration: David R. Brisbourne, Lotus Design

ON THE DRAWING BOARD

High fuel economy, and high performance, are not mutually exclusive items, says Lotus Engineering. Indeed, as per a request by *Automotive Industries*, Lotus has brainstormed a concept vehicle that would seem to satisfy Senator Bryan, the auto industry, mom and even Ayrton Senna. Basically, Lotus has designed a seven-passenger vehicle, powered by a 1.2 L engine that would deliver 60 mpg and achieve 0-100 km/h times in six seconds!

Ken Sears, Chief Engineer, Vehicle Concepts at Lotus Engineering explains:

"The technology expected to appear in the next five to 10 years will be the basis for vehicles in the year 2010, so the future is not far away. And buyers will demand improved performance, durability, and safety – all with higher equipment and refinement levels. Thus the materials industry must make commercially available recyclable materials with properties significantly beyond today's norms.

"Because the size and number of occupants and highways will be much the same as today, vehicle size can't change radically. Optimized packaging will allow occupant and luggage space within a shorter overall length, more vehicles per mile of highway, fewer

parking problems, better passenger comfort and crash protection—without greatly increasing frontal area and aerodynamic drag.

"The vehicle pictured is powered by a 1.2 L four-stroke, four valve/cylinder piston engine producing 134 hp [100 kW] and 150 lb/ft of torque. High-pressure charged induction [supercharging], direct fuel injection, and computer-controlled individual valve actuation [there are no camshafts] will ensure very high efficiency, and more than 100 hp/L—but with vastly improved fuel economy and exhaust emissions. Aluminum is used for major casings, plastics for smaller parts, high-performance alloy steel for stressed components, and ceramic composites for the most arduous heat and stress areas.

"The engine is coupled to a high efficiency CVT. An electronic powertrain management system controls engine operating speed and load, valve lift and timing, induction pressure, fuel injection—and the transmission—to optimize efficiency at all power demands. Our simulations confirm expected huge improvements in performance and economy through reduced systems inefficiency and optimized powertrain control.

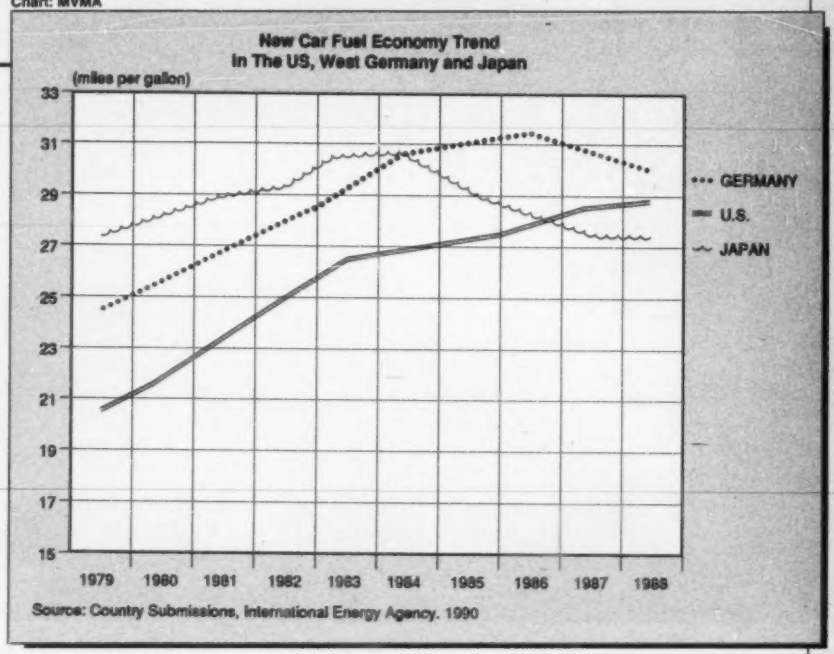
"Comfort, control and safety are enhanced by the active suspension system which is tied into the powertrain computer. This helps reduce its power consumption. A noise cancellation exhaust is also featured.

"The 2206 lb [1000 kg] vehicle sits on a 102 in. wheelbase. Overall length is 174 in. which offers seven passenger capacity. The front passenger seat can face rearward, and the rear seats slide fore and aft. The middle seats can be folded into the floor, and by removing the rear seats and part of the center console creates a flat load space."

CONCLUSION

Can the automotive industry achieve a 40% improvement in CAFE standards? You bet. But cars would become smaller, slower and much, much more expensive than they are today. And when given the choice, consumers have overwhelmingly opted for comfort, convenience and performance—not fuel economy.

Chart: MVMA



Higher gas taxes? It hasn't helped CAFE much in Europe and Japan.

So maybe Congress is going about it the wrong way. But the auto industry has certainly left a vacuum for Congress to fill. As far as the public is concerned, the industry creates the impression that it is dead set against doing anything. And yet, the auto industry has a positive story to tell. But to wrest the initiative away from Congress it must be proactive, not reactive. It must show the nation that it too has a plan to reduce the nation's dependence on oil.

First of all, we think the industry could push for faster development of Intelligent Vehicle Highway Systems (IVHS). These interactive 'smart' roads, now being tested in 22 states and 26 cities, can 'read' traffic densities and greatly improve traffic flow. Indeed, a recent CalTrans study of traffic congestion stated that if congestion causes rush hour traffic speeds to drop from 30 mph to 10 mph, fuel consumption increases 100%, with large increases in exhaust emissions.

Second, anything that could be done to get pre-1983 vehicles off the road—those with the worst fuel economy and exhaust emissions—would have the greatest short-term effect. Perhaps this could be done through one-time tax breaks, or sales incentives. Obviously, mandating their removal wouldn't be feasible, as it would hit poor people the hardest. But it would reduce US gasoline consumption in a hurry.

Third, accelerating electric and alternative-fueled vehicle development and production, would reduce US consumption of imported oil. But until alternate fuels are available at the corner gas station, all the talk about these fuels is just that—talk.

Fourth, calls for higher gasoline taxes should be dismissed outright. Though gasoline in Europe and Japan costs three to four times as much as it does in the US, their CAFE levels are not much higher (see accompanying graph).

Lastly, Congress must take responsibility for legislating regulations with a common sense approach. All too often automakers are forced to comply with regulations that work against each other. For example, tighter emission standards adversely affect fuel economy. And safety legislation usually requires additional equipment that adds weight, which causes fuel economy to decrease. Obviously, improvements in emissions, fuel economy and safety are areas best left to the regulatory process—not market competition.

But unless the auto industry gets out ahead of the issues and helps to set the debate, it can look forward to a future where 'Bryan bills' are the norm, not the exception. AJ

CHILTON'S

AUTOMOTIVE INDUSTRIES

AUGUST 1991

TOHI SUPPLIER PROFILE ISSUE

THE PEOPLE - THE PROCESS

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Charles 'Chuck' Jordan
VP Design Staff

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Volume 171, No. 8 August 1991

In only 18 months GM's Chuck Jordan retires. Page 26. Cover Photography: Rob Johns

CHILTON'S AUTOMOTIVE INDUSTRIES

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GM races to find a new design chief.

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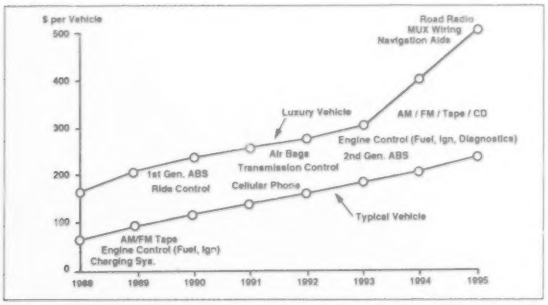
by LINDSAY BROOKE

NEW HORIZONS

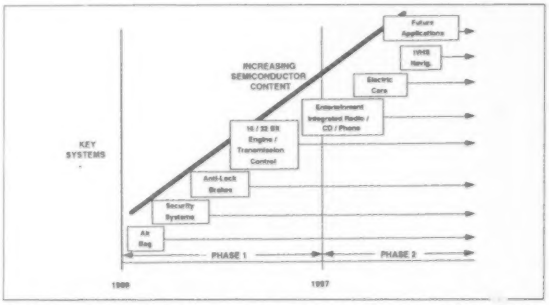
Motorola maps out the future of automotive electronics and sums it up in one word: Speed. But there's a lot more coming.

What's the number one challenge in automotive electronics today? "Well, that's easy," says Greg Williams, vp of Motorola's automotive semiconductor group. "I can sum it up in one word: Speed."

Cost, he says, is certainly an important consideration. But speed, both in product development cycles and product performance, is the main concern for Motorola (which currently supplies



Average North American vehicle semiconductor content, through 1995



Systems roadmap: more automotive semiconductors, 1997 and beyond

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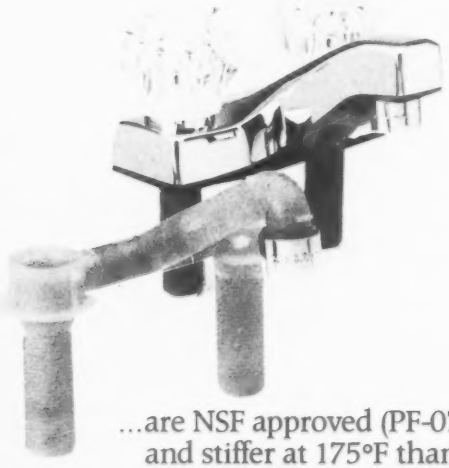

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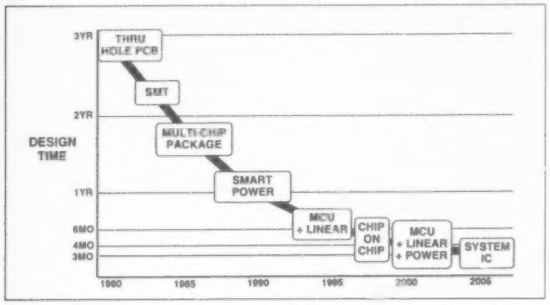
semiconductors for eight of the top 12 automotive OE control units), and for the auto electronics industry.

Speaking at the recent "Horizons" meeting in Austin, Texas, where Motorola mapped out its plans for the various electronics market segments, Williams and his Automotive group colleagues discussed the current state of the industry, today's technology and what they see coming in the future. The following is a snapshot of the "Horizons" meeting, including Motorola-supplied chart information.

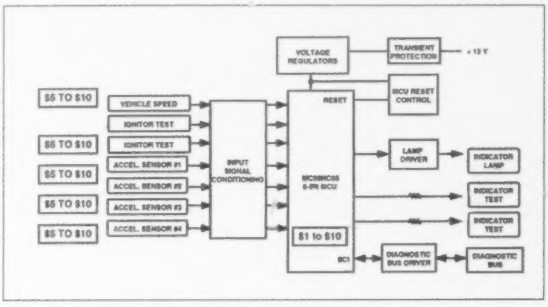
• Faster is best: The electronics industry needs to get new products to market in *half* the time it now takes, says Greg Williams. The solution is more teamwork at the systems level, not just on the components level.

• Future product cycles: Will be 6-12 months total – and faster. Toyota's new 16-bit microprocessor, based on a Motorola 68000-series core, was a sub-36 month project which utilized a 'systems team.' Products will be developed on a 'feature' basis and driven by marketing. The complexity of some electronics products will increase by as much as a factor of 50, compared with their current counterparts, says Motorola. Reducing engine emissions will continue to eat up R&D budgets and engineering time.

• How to work with Motorola: Develop cross-functional teams to lay out



System integration through year 2005. Note reduced cycle times.



Cost of some airbag system components, according to Motorola.

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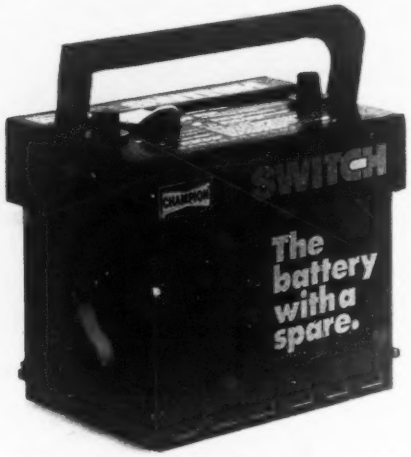

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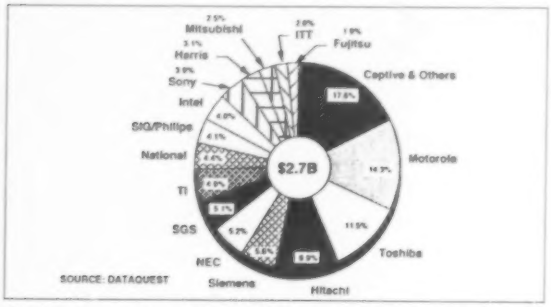
the vision and integrate the functions needed for a program, reduce pin count, coordinate the car group with active and passive component suppliers, and bring the 'manufacturing guys' in upstream.

Motorola has applied this approach with Ford, and with GM and Delco Moraine in developing the ABS VI system.

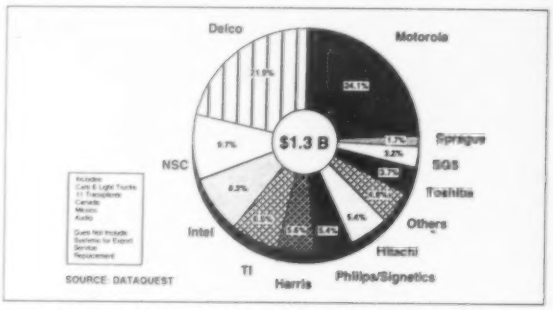
• Dealing with Japan's *kieretsus*: This is key to getting into Japan to do business long-term, says Greg Williams. "Suppliers don't have to give up anything," he maintains. "The Japanese are looking for new, attractive technology that they don't have." He points to his company's 400% growth in Japan due to ventures with Nippondenso, which will come from 16-bit technology and Smart-MOS, as well as expanded deals with the Europeans (ABS controllers and diagnostics).

Quality is "more important than product" in this regard, Williams notes. This includes management relations and response to customer-related problems. Motorola adopted Toyota's quality process model in 1988, and developed benchmarks and a best-in-class process portfolio in each major phase (concept, design, manufacturing, service).

Local design capability and the quality of service, including JIT production, are also 'musts,' even if manufacturing is to be done by a Japanese



World automotive semiconductor market share (1989). Source: Dataquest.



North American automotive semiconductor market share (1989), including transplants, Canada, Mexico, audio.

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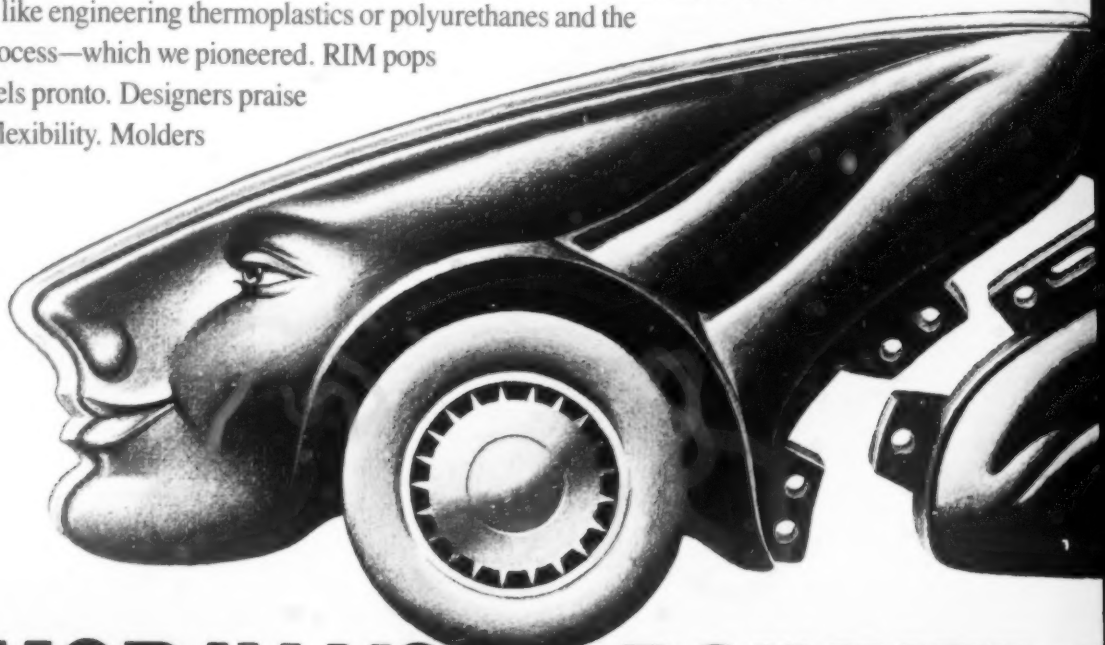

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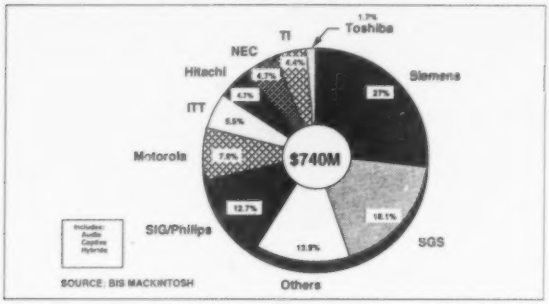
joint-venture partner. To improve communications, American design engineers should take courses in conversational Japanese, as Williams has done himself.

• Dealing with the transplants: Motorola has an automotive focus and design team in Japan. Some of the company's design is done in Tokyo but can be produced in any plant. "Get qualified in Japan and supply globally," advises Williams, who says that supplier qualification is equally rigorous in Japan and in the US.

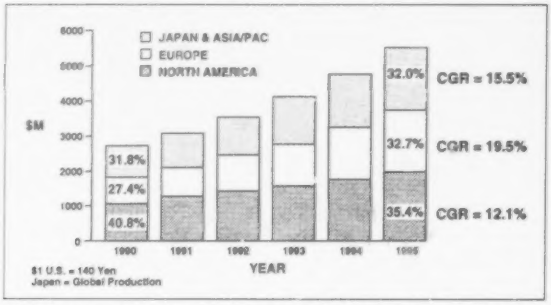
• Design wins: Focus on long-term projects – "next-generation stuff," Williams says. Cross-functional teams should target major technology and identify opportunities at the design stage.

• Electric vehicles: Power is still a major difficulty in designing these vehicles. There are also too many connectors and solder joints, so multiplexing may be one solution; 'smart power' and more functionality may be others. Motorola's initial interest in electric vehicles is in power motor drives, says Williams. Tire pressure sensors could also be a big potential market here, as electrics will probably run high-pressure tires.

• What's exciting? To Greg Williams, three major areas – sensors, electric vehicles, and intelligent vehicle highways systems, along with DSP. AI



European automotive semiconductor market share (1989), including audio, captive and hybrids. Source: BIS Mackintosh.



World automotive semiconductor market, 1990-1995, showing compounded growth (CGR).

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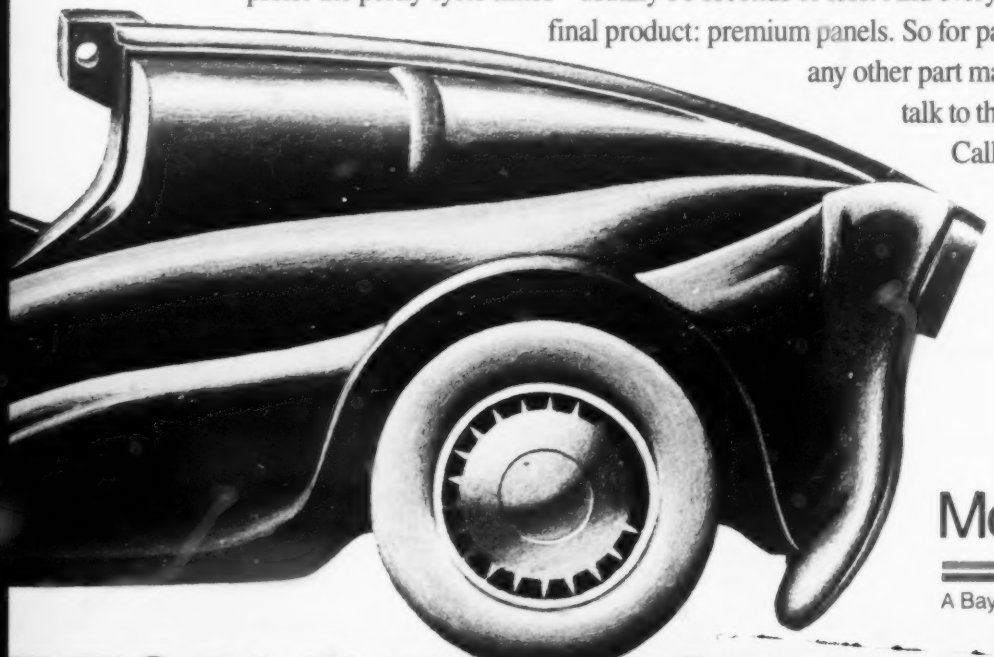

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